

SECTION 910 -- METAL MATERIALS

910.01 Reinforcing Bars and Dowel Bars.

10 (a) **General.** Unless otherwise specified, bars for concrete reinforcement shall be deformed billet steel, grade 420 (60). The bars for cement concrete pavement shall be deformed billet steel, except tie bars that shall be bent and subsequently straightened during construction shall be deformed bars in accordance with ASTM A615/A615M, grade 300 (40). Tie bar assemblies used in lieu of bent tie bars shall be in accordance with the minimum total ultimate strength and minimum total yield strength requirements specified for bent tie bars; bend test and elongation will not be required.

Reinforcing steel used in precast or precast prestressed concrete structural members, including deck panels, shall be in accordance with ASTM A615/A615M, grade 420 (60).

20 Reinforcing bars will be jobsite sampled in accordance with the Frequency Manual and, when shipped to the project site, the bars shall be accompanied by the types of certifications specified in the Frequency Manual and in accordance with 916. As an alternate procedure, the reinforcing bars may be furnished by selecting bars made by a manufacturer on the list of Certified Uncoated Reinforcing Bar Manufacturers and in accordance with ITM 301. When shipped to the project site, the reinforcing bars shall be accompanied by the types of certifications specified in ITM 301 and in accordance with 916.

(b) Specific Requirements.

1. **Billet Steel Bars.** Billet steel bars shall be in accordance with ASTM A615/A615M.

30 2. **Threaded Tie Bar Assembly.** The threaded tie bar assembly shall be deformed billet steel, grade 420 (60), in accordance with 910.01(b)1 and a coupling device. The tie assembly shall achieve a minimum load of 525 MPa (76.144 kip/in²). An epoxy coating with a minimum film thickness of 150 Φ m (6 mils) shall be applied to the coupling device.

40 3. **Splicing Systems.** Reinforcing steel splicing systems shall be selected from the list of approved Reinforcing Steel Splicing Systems. A manufacturer may request to have a splicing system added to the list by submitting three randomly selected epoxy coated bars of each bar designation to be included as an approved splicing system on the list. The samples furnished shall be assembled. The splicing system will be tested for tensile strength in accordance with ASTM A 370 and shall reach 150 percent of the specified yield on all three samples for each bar size submitted. Splicing systems demonstrating consistent, repeatable, and passing test results will be added to the list. Approved bar designations will be noted on the list.

4. **Blank.**

5. **Welded Steel Wire Fabric for Concrete Reinforcement.** Welded smooth steel wire fabric for concrete reinforcement shall be in accordance with ASTM A 185, except as follows:

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- a. The wire used in manufacturing the fabric shall be as drawn, not galvanized, unless otherwise specified.
 - b. The fabric shall be furnished in flat sheets unless otherwise permitted or specified.
 - c. Weld shear tests of fabric will be performed on the test specimens obtained for testing tensile properties in accordance with the Frequency Manual. If there is weld shear failure, additional test specimens shall be obtained in accordance with ASTM A 185.
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6. Welded Deformed Steel Wire Fabric for Concrete Reinforcement.

Welded deformed steel wire fabric for concrete reinforcement shall be in accordance with ASTM A 497, except as follows:

- a. The wire used in manufacturing the fabric shall be in accordance with ASTM A 496.
 - b. The fabric shall be furnished in flat sheets unless otherwise specified or permitted.
 - c. Weld shear tests of fabric will be performed on the test specimens obtained for testing tensile properties in accordance with the Frequency Manual. If there is shear failure, additional test specimens shall be obtained in accordance with ASTM A 497.
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7. Uncoated 7 Wire Strand for Prestressed Concrete. Uncoated 7 wire strand for prestressed concrete shall be in accordance with ASTM A 416. The strand shall have the minimum tensile strength of and initial tension shown on the plans.

80 Low relaxation strand with a nominal diameter of 12.70 mm (1/2 in.) and a cross sectional area of 108 mm² (0.167 in²) shall have a breaking strength of 20 400 kg (45,000 lb).

Uncoated 7 wire strand shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916.

8. Steel Spiral Reinforcement. Steel spiral reinforcement shall be either:

- a. deformed billet steel, ASTM A 615/A 615M, grade 420 (60); or
 - b. cold drawn steel wire, ASTM A 82.
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9. Epoxy Coated Reinforcing Bars. Epoxy coated reinforcing bars will be jobsite sampled in accordance with the Frequency Manual. As an alternate procedure, the reinforcing bars may be furnished by selecting bars coated from an applicator's plant on the list of Certified Reinforcing Bar Epoxy Coaters and in accordance with ITM 301. The epoxy coating material shall be selected from the list of approved Epoxy Coating for Steel.

100 Epoxy coated reinforcing bars shall be in accordance with ASTM A 775/A 775M,
except as follows:

- a. the steel shall be in accordance with 910.01(b)1;
- b. the coating color shall contrast with the color of iron oxide;
- c. tensile and bend tests shall be performed on the bars. If an examination of the bend test specimen suggests the need, the adhesion of the coating shall be checked by subjecting additional specimens to the 120E bend test. Hairline cracks without bond loss will be acceptable provided there are not more than two and the length of either crack does not exceed 6 mm (1/4 in.). The coating thickness shall be 150 to 300 μm (6 to 12 mils) after cure. The thickness measurements shall be made in accordance with ASTM G 12. The average shall be based on 12 individual readings. No specific correction for the base preparation process shall be applied to the thickness measurements.
- d. epoxy coated reinforcing bars which will be jobsite sampled shall be accompanied by the types of certifications in the Frequency Manual and in accordance with 916. Epoxy coated reinforcing bars furnished by coaters on the list of Certified Reinforcing Bar Epoxy Coaters shall be accompanied by the types of certifications specified in ITM 301 and in accordance with 916.
- e. repair and handling procedures shall be in accordance with 703.04. The coating material shall be in accordance with the Annex to ASTM D 3963/D 3963M.

130 Epoxy coated support devices for epoxy coated reinforcing bars shall be in
accordance with ASTM A 775/A 775M, except as follows:

- a. the steel shall be in accordance with 910.01(b)1;
- b. the coating color shall contrast with the color of iron oxide;
- c. the coating thickness shall be 150 to 300 μm (6 to 12 mils) after cure. The thickness measurements shall be made in accordance with ASTM G 12.

140 **10. Dowel Bars.** Dowel bars shall be plain billet steel in accordance with ASTM A 615/A 615M, grade 300 (40), except the bend test and elongation requirements will not apply. The dowel bar area and mass (weight) for the nominal bar diameter shall be as follows:

Nominal Bar Diameter, mm (in.)	Cross Sectional Area, mm ² (in. ²)	Mass (Weight) kg/m (lb/ft)
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	25 (1)	510 (0.79)	3.973 (2.670)
	32 (1 1/4)	794 (1.23)	6.209 (4.172)
150	33 (1 5/16)	871 (1.35)	6.846 (4.600)
	38 (1 1/2)	1142 (1.77)	8.941 (6.008)

Dowel bars shall be coated with an epoxy coating material selected from the list of approved Epoxy Coating for Steel. The coating thickness after cure shall be a minimum of 175 µm (7 mils). Dowel bars shall not have burring or other deformation restricting slippage in concrete. Dowel bar ends shall be saw cut. Chips from the cutting operation shall be removed from coated bars.

160 Dowel bars will be jobsite sampled in accordance with the Frequency Manual and, when shipped to the project site, the bars shall be accompanied by the types of certifications specified in the Frequency Manual and in accordance with 916. As an alternate procedure, the dowel bars may be furnished by selecting bars made by a coater and manufacturer on the list of Certified Reinforcing Bar Epoxy Coaters and in accordance with ITM 301. When shipped to the project site, the dowel bars shall be accompanied by the types of certifications specified in ITM 301 and in accordance with 916.

(c) Inspection, Sampling, and Testing. All reinforcing steel may be inspected, sampled, and tested after delivery to the project.

170 **910.02 Structural Steel.**

(a) Structural Steel. Unless otherwise specified, structural steel shall be in accordance with A 709M grade 250 (ASTM A 709 grade 36).

(b) High Strength Structural Steel. This steel, when specified, shall be in accordance with ASTM A 709M grade 690 (ASTM A 709 grade 100); ASTM A 709M grade 345 (ASTM A 709, grade 50; or ASTM A 709M grade 345W (ASTM A 709 grade 50W)).

180 The corrosion resistance of ASTM A 709M grade 345W (ASTM A 709 grade 50W) steel shall be at least four times that of structural carbon steel. The steel fabricator, when placing the order, shall state that the steel is for bridge use, and that the steel shall be used in the bare, unpainted condition.

All fasteners used in conjunction with ASTM A 709M grade 345W (ASTM A 709 grade 50W) steel shall be friction type high-strength steel bolts in accordance with ASTM A 325M (ASTM A 325) Type III. Certification and a sample shall be submitted to the Engineer prior to start of erection.

190 All plates and bars produced from ASTM A 572M (ASTM A 572) steel over 19 mm (3/4 in.) in thickness shall be "killed fine grain practice".

(c) Charpy V-Notch Toughness Tests. Structural steel, except members exempted below, shall meet the longitudinal Charpy V-Notch test requirement as specified in the following table for the type or types of steel specified or furnished. Sampling and

testing procedures shall be in accordance with ASTM A 673M (ASTM A 673). The H frequency of heat testing shall be used. Charpy V-Notch test data shall be included on the mill test reports for structural steel specified in 711.08 and 916.

ASTM Designation	Thickness-mm (in.)	Joule (J) Foot-Pounds @ 4EC (40EF)
A 709M grade 250 (A 709 grade 36)		20.3 (15)
A 709 grade 345* (A 709 grade 50)*	Up to 100 mm mechanically fastened (4 in.) Up to 50 mm welded (2 in.)	20.3 (15) 20.3 (15)
A 709M grade 345W* (A 709 grade 50W)*	Up to 100 mm mechanically fastened (4 in.) Up to 50 mm welded (2 in.) Over 50 mm to 100 mm welded (2 in. to 4 in.)	20.3 (15) 20.3 (15) 27.1 (20)

* If the yield point of the material exceeds 450 MPa (65,000 psi), the temperature for the CVN value for acceptability shall be reduced by -10EC (15EF) for each increment of 69 MPa (10,000 psi) above 450 MPa (65,000 psi).

This test requirement shall apply to all structural steel members and/or components except diaphragms, cross frames, stiffeners, lateral bracing, railroad ballast retainers and components, shoe assemblies, expansion joints, and compression members of trusses.

(d) Mill Test Reports. Mill test reports for structural steel shall be in accordance with 711.08 and 916 and shall include Charpy-Impact test data as set out in 910.02(c).

(e) High Strength Bolts, Nuts, and Washers.

1. General Use. High strength bolts shall be in accordance with ASTM A 325M (ASTM A 325). Type 3 bolts will be required if the structural steel is to remain unpainted. High strength nuts shall be of the grade and finish specified in ASTM A 325M (ASTM A 325) and in accordance with ASTM A 563M (ASTM A 563) or ASTM A 194M (ASTM A 194). High strength washers shall be of the type specified in ASTM A 325M (ASTM A 325) and in accordance with ASTM F 436. The bolts, washers, and nuts shall be coated after fabrication in accordance with ASTM A 153, class C or AASHTO M 298, class 55.

2. Assembly of Structural Steel in Bridges. High strength bolts, nuts, and washers used in the assembly of structural steel in bridges, excluding shoes and bearing assemblies, shall be provided in accordance with 910.02(e)1 and the following additional requirements.

a. Bolts. The maximum tensile strength shall be 1034 MPa (150,000 psi) for bolts 25 mm (1 in.) or less in diameter. The maximum tensile strength shall be 827 MPa (120,000 psi) for bolts greater than 25 mm (1 in.) in diameter. The maximum hardness shall be 33 Rc.

b. Nuts. The nuts shall be in accordance with ASTM A 563M (ASTM A 563), grade DH; or ASTM A 194M (ASTM A 194), grade 2H.

c. Tests.

(1) **Rotational Capacity.** High Strength fasteners shall be subjected to the rotational capacity test in accordance with AASHTO M 164, Section 8.5. The fastener shall complete two times the required number of turns from snug tight conditions in accordance with AASHTO Standard Specifications for Highway Bridges, Division II, in a Skidmore-Wilhelm calibrator or equivalent tension measuring device without stripping or failure. During this test, the maximum recorded tension shall be at least 1.15 times the required fastener tension indicated in AASHTO Standard Specifications for Highway Bridges, Division II. The measured torque required to produce the required fastener tension shall not exceed the value obtained by the following equation.

$$\text{Torque} = 0.25 PD$$

Where:

Torque = Measured Torque, (newton meters) (foot-pounds)

P = Measured Bolt Tension, (newtons) (pounds)

D = Nominal Diameter (meters) (feet)

(2) **Proof Loads.** Proof load tests for bolts shall be conducted in accordance with ASTM F 606, Section 3.2.3. Proof load test for nuts shall be conducted in accordance with ASTM F 606, Section 4.2.

(3) **Wedge Tension Test.** The wedge tests of full size bolts shall be performed in accordance with ASTM F 606, Section 3.5.

d. **Certification.** The supplier shall provide a certification of compliance with all requirements for high strength bolts, nuts, and washers used in the assembly of structural steel in bridges, excluding shoes and bearing assemblies. The certification, in addition to complying with the applicable requirements of 916, shall include the lot number on the shipping package and indicate when or where all testing was performed.

(f) Bolts other than High Strength Bolts.

1. **General.** Bolts shall be unfinished, turned, or ribbed bolts conforming to the requirements for Grade A bolts of specification for low carbon steel externally and internally threaded fasteners, ASTM A 307. Bolts shall have single, self-locking nuts or double nuts unless otherwise shown on the plans or in the special provisions. Beveled washers shall be used where bearing faces have a slope of more than one to 20 with respect to a plane normal to the bolt axis.

Bolts, washers, and nuts utilized in the U channel steel post splice as shown on the plans shall be in accordance with ASTM A 449, SAE J429-G7.9, or ASTM A 325M (ASTM A 325) and shall be galvanized.

2. **Unfinished Bolts.** Unfinished bolts shall be furnished unless other types are specified.

3. Turned Bolts. The surface of the body of turned bolts shall meet the ANSI roughness rating value of 125. Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed. Bolts furnished shall provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

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4. Ribbed Bolts. The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 2 mm (5/64 in.) greater than the nominal diameter specified for the bolts. Ribbed bolts shall be furnished with round heads conforming to requirements of ANSI B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the hole shall be carefully reamed and an over sized bolt used as a replacement.

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910.03 Permanent Metal Forms. Metal bridge deck forms and supports shall be fabricated from steel in accordance with ASTM A 653M (ASTM A 653) for grades A through E having a coating class of G165 in accordance with ASTM A 525M (ASTM A 525).

Material furnished under this specification shall be covered by the type of certification specified in the Frequency Manual and in accordance with 916. The certification shall list the yield tensile stresses, the ultimate tensile stresses, the ultimate tensile elongations, the base metal thicknesses, the masses (weights) of the galvanized coating, and shall certify that the material complies with the specified material requirements. The properties and parameters shall be listed for each thickness (gage) of material used in the panels and the hardware necessary to erect them. The materials will be sampled at the work site and shall include a representative portion of a panel of each thickness (gage) to be used and a representative portion of each type and size of hardware necessary to erect the panels, excluding the fasteners.

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910.04 Steel Forgings and Steel Shafting.

(a) Carbon Steel Forgings. Steel forgings shall be in accordance with ASTM A 668 for carbon steel forgings for general industrial use. Class F forgings shall be furnished unless otherwise specified.

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(b) Cold Finished Carbon Steel Shafting. Shafting shall be in accordance with ASTM A 108 for cold finished carbon steel bars and shafting. Grade designation 1016-1030, inclusive, shall be furnished unless otherwise specified.

(c) Alloy Steel Forgings. Alloy steel forgings shall be in accordance with ASTM A 668 for alloy steel forgings for general industrial use. Class G forgings shall be furnished unless otherwise specified.

330 **(d) Certification.** Steel Forgings and Steel Shafting shall be covered by a mill certification reporting the test results of:

1. Chemical analysis
2. Heat treatment, not required for shafting
3. Tensile strength, yield strength, and elongation

Elongation is not required for shafting.

340 **910.05 Castings.** The casting design shall be proof loaded to 178 kN (40,000 lb) in accordance with Federal Specification RR-F-621. Castings shall be in accordance with the plan dimensions and to the following requirements for the designated materials. A certified inspection report shall be submitted by the manufacturer with each shipment of castings, except as otherwise provided herein. Inspection and testing shall be done by the manufacturer. The certified inspection report shall list the casting date, casting number, and the type of material, such as gray iron, ductile iron, etc. It shall state that inspection and testing has been performed, that all parts shipped meet the pertinent specification requirements, and that all component parts fit. The supporting test results, including proof
350 load data, shall be retained and be available on request for a period of seven years. All castings shall have the manufacturer's identification and the date of manufacture cast on an exposed surface. Acceptance of castings will be based on the certified inspection report, visual inspection, and check measurements.

(a) Steel Castings.

1. Steel Castings for Highway Bridges. Steel castings for use in highway bridge components shall be in accordance with AASHTO M 192M (AASHTO M 192), class 620 (90).

360 **2. Chromium Alloy Steel Castings.** These castings shall be in accordance with ASTM A 743M (ASTM A 743). Grade CA 15 shall be furnished unless otherwise specified.

(b) Iron Castings. Iron castings shall be gray iron castings in accordance with ASTM A 48, class No. 35B, unless otherwise specified. Tension tests will be required for all castings including drainage castings.

370 Castings shall be true to pattern in form and dimensions. A tolerance of ∇ 3 mm (∇ 1/8 in.) in general dimensions as shown on the plans will be permitted with the exception that the tolerance in the dimensions of grates or covers and the openings into which they fit shall be limited to ∇ 2 mm (∇ 1/16 in.). All castings shall weigh at least 95 percent of the specified mass (weight) of that type cast to the exact dimensions shown on the plans. They shall be free from sponginess, cracks, blowholes, warping, sand inclusions, cold shots, cold shuts, chilled iron shrinks, or any defects which would affect the strength and value for the intended purpose. The castings shall completely fill the molds and shall not be removed until properly cooled. The casting date and a casting code number shall be cast on each casting.

380 All corners of the castings shall be filleted and outside corners and edges shall be rounded to a radius of not less than 3 mm (1/8 in.). All contact surfaces between different castings shall present a firm and even bearing without rattling or rocking. The lid frame bearing surfaces on all round castings shall be machine milled to provide true bearings around the entire circumference. All other contact surfaces shall be ground.

All castings shall be cleaned of molding or core sand, rust, scale, and foreign material just prior to shipment. Iron castings shall be delivered unpainted.

390 **(c) Ductile Iron Castings.** These castings shall be in accordance with ASTM A 536. Grade 65-45-12 shall be furnished unless otherwise specified. In addition, they shall be in accordance with all requirements of 910.05(b), except the first paragraph.

(d) Malleable Castings. Malleable castings shall be in accordance with ASTM A 47M (ASTM A 47). Grade No. 32510 or 35018 shall be furnished unless otherwise specified. In addition, they shall be in accordance with all requirements of 910.05(b), except the first paragraph.

400 **(e) Carbon Steel Castings.** These castings shall be in accordance with of ASTM A 27M (ASTM A 27). The grade shall be 60-30, 65-35, or 70-36.

Castings shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blowholes, and any defects in positions affecting their strength and value for the service intended.

Blowholes appearing on finished castings shall be located so that a straight line laid in any direction does not cut a total length of cavity greater than 25 mm (1 in.) in any 0.3 m (1 ft) nor shall any single hole exceed 25 mm (1 in.) in any dimension or have an area greater than 323 mm² (1/2 in.²). Blowholes shall not be deep enough to affect the strength of the casting adversely.

410 Minor defects which do not impair strength may, with approval, be welded by an approved process. Defects shall be removed in solid metal by chipping, drilling, or other satisfactory methods and, after welding, the castings shall be annealed if required. Castings which have been welded without permission will be rejected. No sharp unfilleted angles or corners will be allowed.

910.06 Bronze and Copper Alloy.

420 **(a) Bronze Castings.** Bronze castings shall be in accordance with ASTM B 22, alloys 911 or 913. Material furnished under this specification shall be covered by a type A certification in accordance with 916.

(b) Copper Alloy Plates. Copper alloy plates shall be in accordance with of ASTM B 100. Material furnished under this specification shall be covered by a type A certification in accordance with 916.

910.07 Steel Drain Pipe. Steel drain pipe may be welded or seamless, black or galvanized, and shall be in accordance ASTM A 53 except as follows:

Chemical	Furnace Butt Welded	Seamless or Electric Resistance Welded
Carbon, % max.	0.20	0.20
Manganese, % max.	1.00	1.06
Phosphorous, % max.	0.08	0.05
Sulphur, % max.	0.05	0.05
Copper, %	0.75-1.25	0.75-1.25
Nickel, %	1.60-2.20	1.60-2.20
Tensile Strength, min. MPa (psi)	379 (55,000)	448 (65,000)
Yield Point, min. psi (Pascal) Pa	276 (40,000)	317 (46,000)

The minimum elongation for furnace butt welded pipe shall be 30 percent in 50 mm (2 in.) for seamless pipe, in accordance with ASTM A 53, grade A, and for electric resistance welded pipe, in accordance with ASTM A 53, grade B. Material furnished under this specification shall be covered with a type C certification in accordance with 916.

910.08 Miscellaneous.

(a) Sheet Lead. Sheet lead shall be in accordance with ASTM B 29M (ASTM A 29), common lead.

(b) Sheet Zinc. Sheet zinc shall be in accordance with ASTM B 69, type II.

910.09 Guardrail. Guardrail of the same type shall be interchangeable regardless of the source.

(a) Steel Beam Rail. Steel beam rail shall be galvanized, corrugated, sheet steel beams in accordance with AASHTO M 180 as modified herein. The rails, including terminal sections, shall be either class A, base metal nominal thickness of 2.67 mm (0.105 in.), 12 gage, or class B, base metal nominal thickness of 3.43 mm (0.135 in.) 10 gage. They shall be type 2, zinc coated with 1.1 kg/m² (3.60 oz/sq ft) minimum single spot and 1.22 kg/m² (4.00 oz/sq ft) minimum triple spot. Tests for adherence of the coating may be made, including the test specified in ASTM A 123, when deemed necessary.

Where beam rail is set on a curve of 45.7 m (150 ft) radius or less, the rail plate shall be shop curved with its traffic face concave or convex as required. The radii of curvature shall be in increments of 3 m (10 ft) from a radius of 45.7 to 15.2 m (150 to 50 ft) inclusive and in increments of 1.5 m (5 ft) from a radius of 15.2 m (50 ft) to and including 6.1 m (20 ft).

The steel channels specified on the plans shall be standard 127 mm (5 in.) channels weighing 10.0 kg/m (6.7 lb/ft). The material shall be in accordance with ASTM A 36,

(ASTM A 36). The channel shall be galvanized in accordance with ASTM A 123 after fabrication. The mass (weight) of zinc coating per area of actual surface shall average not less than 0.61 kg/m² (2.0 oz/ft²) for any individual piece of channel.

Construction details for the rails and channels shall be as shown on the plans. Whenever field fabrication, as approved, requires cutting or drilling, the cut or drilled member shall be coated with a high zinc dust zinc oxide paint in accordance with of Federal Specification TT-P-641, type II, or Military Specifications DOD-P-21035. When spray paints are used, 2 coats shall be applied.

(b) Aluminum Rail. Aluminum rail shall be semi-elliptical, extruded aluminum rail, in accordance with ASTM B 221M (ASTM B 221), alloy 6061-T6 or 6351-T5. Details shall be as shown on the plans. Curved rail shall be in accordance with 909.11(b).

910.10 Guardrail Posts. Guardrail posts shall be either steel, aluminum, or wood as specified and shall be in accordance with the following requirements.

(a) Steel Guardrail Posts. The dimensions of the steel guardrail posts shall be as shown on the plans. The material shall be in accordance with ASTM A 36M (ASTM A 36). The posts shall be galvanized in accordance with ASTM A 123 after fabrication. However, the mass (weight) of zinc coating per square meter (square foot) of actual surface shall not average less than 610.3 g (2.0 oz) for an individual post.

The mass (weight) of the W6 x 15 post, after fabrication and coating, shall not be less than 21.73 nor more than 23.81 kg/m (14.60 nor more than 16.00 lb/ft).

Construction details shall be as shown on the plans. Whenever field fabrication, as approved, requires cutting or drilling, the cut or drilled member shall be coated with a high zinc dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P-641, Type II, or Military Specifications DOD-P-21035. When spray paints are used, 2 coats shall be applied.

(b) Aluminum Guardrail Posts. The aluminum guardrail posts shall be extruded aluminum, in accordance with ASTM B 221M (ASTM B 221), alloy 6061-T6 or 6351-T5. Dimensions and construction details shall be as shown on the plans.

(c) Wood Guardrail Posts. The wood guardrail posts shall be in accordance with 911.02(d). Dimensions and construction details shall be as shown on the plans.

910.11 Guardrail Accessories, Fittings, and Hardware. These items consist of brackets, splice plates and bars, post anchors, diaphragms, clamps and clamp bars, end caps, connections, anchor rod assemblies, deadmen, bolts, screws, nuts, and washers of the type, dimensions, and design shown on the plans. They shall be in accordance with the requirements set out below. Items of the same type shall be interchangeable regardless of the source.

(a) For Steel Beam Guardrail.

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1. Post brackets, bars, plates and shapes for bridge railing brackets, and plate washers shall be in accordance with ASTM A 36M (ASTM A 36). Post brackets, bars, and plates and shapes for bridge railing brackets shall be galvanized in accordance with 910.10(a). Plate washers shall be galvanized after fabrication in accordance with ASTM A 153. The mass (weight) of the W6 x 15 post bracket shall be in accordance with 910.10(a).
 2. Splice plates and rail portion of bridge railing brackets shall be class B, type 2, in accordance with the first paragraph of 910.09(a).
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3. Bolts and nuts of the sizes specified on the plans shall be in accordance with ASTM A 307. Cut washers and lock washers shall be standard round steel washers of the sizes specified on the plans. The diameter of cut washers shall be 44 mm (1 3/4 in.) for 16 mm (5/8 in.) bolts and 50 mm (2 in.) for 19 mm (3/4 in.) bolts with a thickness of 3.4 mm (0.134 in.) ∇ 0.66 mm (∇ 0.026 in.) measured at the hole. The bolts, washers, and nuts shall be coated after fabrication in accordance with ASTM A 153, or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements for class C of ASTM A 153.
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4. Whenever approved field fabrication requires cutting or drilling, the cut or drilled members shall be coated with a high zinc dust-zinc oxide paint conforming to Federal Specification TT-P-641, type II, or Military Specifications DOD-P21035. When spray paints are used, 2 coats shall be applied.
 5. Pipe spacers of the size specified on the plans shall be galvanized after fabrication in accordance with ASTM A 153, class C. The mass (weight) of coating per square meter (square foot) of actual surface shall average no less than 381 g (1.25 oz) for the specimen tested and shall be no less than 305 g (1.00 oz) for any individual specimen.
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6. For breakaway cable terminal, the rail element, standard bolts, nuts, and washers shall be in accordance with 910.09(a) and requirements 1 and 3 of 910.11(a).

550 High strength bolts shall be in accordance with ASTM A 325M (ASTM A 325) or ASTM A 449. High strength nuts shall be in accordance with ASTM A 563M (ASTM A 563), Grade B or better. Galvanizing shall be in accordance with ASTM A 153 or mechanically galvanized and conform to the coating thickness, adherence, and quality requirements for class C of ASTM A 153. Foundation plates and bearing plate shall be in accordance with ASTM A 36M (ASTM A36), and shall be galvanized after fabrication in accordance with ASTM A 123, except the mass (weight) of zinc coating per square meter (square foot) of actual surface shall average no less than 610 g (2.0 oz) and shall be no less than 549 g (1.8 oz) for any individual specimen. Welding shall be in accordance with AWS D1.1.

560 Terminal posts shall be fabricated from tubing meeting ASTM A 500, Grade B, or
ASTM A 501 and from plates meeting ASTM A 36M (ASTM A 36). Welding shall be in
accordance with AWS D1.1. They shall be galvanized after fabrication in accordance with
ASTM A 123, except the mass (weight) of zinc coating per square meter (square yard) of
actual surface shall average no less than 610 g (2.0 oz). The average for any component part,
including paddle plate, tubing, or base plate, shall be no less than 549 g (1.8 oz).

The steel pipe in the type 5 anchor and the steel spacer tube in the transition type
WGB shall be Schedule 40.

570 Tapered washers may be of steel or malleable iron, and galvanized in accordance
with ASTM A 153.

The steel pipe in the type 5 anchor and the steel spacer tube in the transition type
WGB shall be Schedule 40.

580 The wire rope used in the cable assembly shall be in accordance with AASHTO
M 30 and shall be 19 mm (3/4 in.) preformed, 6 by 9, wire strand core or independent wire
rope core (IWRC), galvanized, right regular lay, manufactured of improved plow steel, with
a minimum specified breaking strength of 190 kN (42,800 lb). The swaged fitting, stud, and
nut shall develop the breaking strength of the wire rope. The fitting shall be galvanized in
accordance with ASTM A 123 before swaging. After galvanizing, the head and nut may be
tapped 0.6 mm (0.023 in.) over the ANSI B1.1, class 2B tolerance.

(b) For Aluminum Guardrail.

1. Splice bars, clamp bars, diaphragms, and brackets shall be aluminum in
accordance with ASTM B 221M (ASTM B 221), alloy 6061-T6 or
6351-T5.
- 590 2. Washers shall be aluminum in accordance with ASTM B 209M (ASTM
B 209), alloy Alclad 2024-T4 or stainless steel in accordance with
ASTM A 276, type 430.
3. Anchor bolts, bracket bolts, cap screws, and nuts shall be stainless steel
in accordance with ASTM A 276, type 304 or 430.
4. Rail end caps shall be aluminum alloy A356.0 in accordance with
ASTM B 26M (ASTM B 26) or ASTM B 108.
- 600 5. Terminal pieces shall be aluminum in accordance with ASTM B 108,
alloy A356.0.
6. All aluminum surfaces in contact with concrete shall be given one shop
coat of zinc chromate paint.

(c) For Steel Tube Guardrail.

- 610
1. Channels and bars for connections, splice bars, and diaphragms shall be in accordance with ASTM A 36 (ASTM A 36).
 2. Cap screws shall be stainless steel in accordance with ASTM A 276, type 304 or 430.
 3. Rail end caps shall be malleable iron castings in accordance with ASTM A 47M (ASTM A 47), grade 35018, or steel castings in accordance with ASTM A 27M (ASTM A 27), grade 70-36.
 4. Cut washers and lock washers shall be standard round steel washers. The diameter of cut washers shall be 37.5 mm (1 1/2 in.) and 3.2 mm (1/8 in.) thick measured at the hole. Washers shall be coated after fabrication in accordance with requirement 3 of 909.11(a).
 5. All materials other than cap screws and washers shall be galvanized after fabrication in accordance with ASTM A 123.
 6. When field fabrication, as approved, requires cutting or drilling, the cut or drilled members shall be coated with a high zinc dust-zinc oxide paint conforming to the requirements of Federal Specification TT-P-641 type II or Military Specifications DOD-P-21035. When spray paints are used, 2 coats shall be applied.
- 620
- 630

910.12 Samples and Certification of Guardrail, Posts, Accessories, Fittings, and Hardware. All samples required for testing purposes shall be furnished free of charge. General requirements for sampling are as follows:

(a) Control Procedure for Furnishing Steel Beam Guardrail and Accessories. All steel beam guardrail and accessories shall be subject to one of the 2 control procedures as follows:

- 640
1. Installers on a certification basis with random in place testing of guardrail
 2. Installers not qualifying or not desiring certification basis with job control sampling

Installers desiring to be on certification status will be approved upon request. The request need not be in writing, but it shall be requested through the Division of Materials and Tests. A 6-digit approval number will be assigned to each installer to be used for identification acceptability of material.

650 The installer shall perform testing or shall obtain documentation to ensure the quality of the material incorporated into the work.

The installer shall prepare and attach to each monthly material record a certification in accordance with 916.02(d). Such certification shall contain the contract number; installer's name; installer's approval number; month of installation; rail manufacturer; bolt

manufacturer; quantities of rail, channel, posts, block, and paddle posts incorporated into the work; quantities of sawed timber posts and blocks for thrie-beam and W-beam guardrail incorporated into the work; and a notarized statement sworn by a person having legal authority to bind the company preparing the certification that the materials furnished are in accordance with 910.09 through 910.12.

The Department will inspect the steel beam guardrail on a randomly selected contract for compliance with specifications for a minimum of one time per year per installer. The inspections will be performed before the contract is certified by the Division of Materials and Tests. Various dimensional checks, various coating thickness determinations, proper identification checks for rail and bolts, bore cores for determination of preservative retention, and penetration for sawed timber posts and blocks for end sections will be performed.

Randomly selected contracts with failing results will be issued a Failed Materials Report. Failed materials will be subject to action by the Failed Materials Committee.

If the installer shows negligence or the inability to ensure the delivery of specified materials, the installer's immediate usage status may be removed.

Suppliers not desiring to retain their certification or who lose status will have their material sampled at the project site after delivery. No material may be used until it has been tested and approved.

Samples will be obtained from materials after delivery to the jobsite or while being held in inventory at the Contractor's yard, if it is located in an area normally serviced by the Department.

(b) Aluminum Guardrail. Rails, posts, accessories, fittings, and hardware will be accepted based on a visual inspection confirming the physical dimensions conform to the requirements as shown on the plans and a type C certification in accordance with 916.

910.13 Steel Fence Posts. Tubular steel fence posts and line posts shall meet the following specifications and the requirements as shown on the plans.

All posts except tubular steel fence posts shall be galvanized in accordance with ASTM A 123, except the mass (weight) of the coating per square meter (square foot) of actual surface on anchor plates attached to posts shall average no less than 458 g (1.50 oz) and shall be no less than 382 g (1.25 oz) for any individual specimen. Posts and anchor plates for line posts shall be of good commercial quality steel and of the shapes, weights, and dimensions shown on the plans.

Line posts for farm field fence shall be furnished with anchor plates. End, corner, pull, and gate posts for farm field type fence shall be furnished with braces and all fittings and details required to make a complete installation as shown on the plans.

(a) Tubular Steel Fence Posts. Two groups of tubular steel fence posts are included in these specifications. Tubular section posts shall have heavy malleable iron caps or pressed galvanized steel caps. Such caps shall be made to provide a drive fit over the

outside of the section to exclude moisture. The mass (weight) per meter (foot) for tubular posts and braces shall be no less than 90 percent of the mass (weight) specified. Unless specified otherwise, the tubular steel fence post shall be group 1.

710 **1. Group 1.** Tubular steel fence posts for group I shall be hot-dipped zinc-coated and shall be in accordance with ASTM F 1083 except tests shall be conducted on sample posts selected as being representative of the posts furnished. The mass (weight) per meter (foot) will be acceptable provided it is at least 90 percent of the specified mass (weight).

720 **2. Group 2.** Tubular steel fence posts for group 2 shall have a minimum 345 MPa (50 ksi) yield strength and be in accordance with AASHTO M 181, except that the inner pipe surface may be galvanized in lieu of a zinc rich coating or hot dipped aluminum coated, Type 2, meeting the chemical requirements of AASHTO M 274. The aluminum coated, Type 2, steel fence posts shall be manufactured by roll forming aluminum coated, Type 2, steel strip and electric resistance welding it into tubular form. The outside of the weld area shall be metallized with commercially pure aluminum to a thickness sufficient to provide resistance to corrosion equal to that of the remainder of the outside of the post. The aluminum coating mass (weight) shall be a minimum of 229 g/m² (0.75 oz/sq ft) average, and 214 g/m² (0.70 oz/sq ft) for an individual test specimen, as measured in accordance with ASTM A 428. Specimens for determining weight of coating shall be obtained in accordance with ASTM F 1083.

730 **(b) Fence Fastenings.** When fastenings are necessary for attaching the farm field fence to the posts, they shall be either galvanized or aluminum coated 3.8 mm (No. 9) wire, or galvanized or aluminum coated clamps of the manufacturer's standard design. The coating weights shall be a minimum of 183 g/m² and 92 g/m² (0.60 oz/sq ft and 0.30 oz/sq ft) for galvanized and aluminum coated, respectively. A sufficient quantity of individual tie wires or clamps shall be furnished to provide for five attachments of the fencing to each line post and one tie wire for each strand of barbed or tension wire.

740 Line posts for chain link type fence shall be furnished with the necessary tie wires or fabric bands for fastening the fabric to the posts. These fastenings shall be made of aluminum strip or wire of approved gage and design or of galvanized steel wire and may be in accordance with the manufacturer's standard design. If galvanized steel wire ties are furnished, the wire shall be no smaller than No. 9 gage (3.8 mm). A sufficient quantity of individual ties or bands shall be furnished to provide for attaching the fabric to each line post each 0.3 m (12 in.) or as called for on the plans.

910.14 Sign Posts.

(a) Steel, Flanged, Channel Posts.

750 **1. General Requirements.** Posts shall be made from open hearth, basic oxygen, or electric furnace steel rolled from standard tee rails or new billets. The steel used in the posts shall conform to the physical properties of ASTM A 499, grade 60, and to the chemical composition of ASTM A 1 for 45 kg/m (91 lb/yd) or larger steel rails.

Posts fabricated from other steels will be acceptable providing that the following criteria are met. A notarized copy of a dynamic crash test report shall be furnished substantiating that the posts manufactured from this material, when double mounted in a 2.1 m (7 ft) span, conform to the breakaway requirements of AASHTO, Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, except that the maximum change in velocity shall not exceed 4.9 m (16 ft) per second. For 2 posts in a 2.1 m (7 ft) path, impact performance may be estimated by multiplying the vehicle energy loss observed in a single post crash test by 2. This estimated double post energy loss may then be used to calculate an estimated impact velocity change and momentum change for a double post sign design. The minimum yield strength shall be 414 MPa (60,000 psi) and the minimum tensile strength shall be 621 MPa (90,000 psi).

The tensile strength shall be determined by either the standard Rockwell Hardness test, Brinell Hardness test, or by actual tensile test. The Rockwell Hardness shall be a minimum of B 91. The yield strength shall be determined by the manufacturer by actual test. Tensile and yield strengths and chemical composition shall be determined by the average from the three latest test results the manufacturer has available at the time of shipment. These test results need not be made on the materials from which the posts were made. However, the tests must have been made within 90 days of shipment. Posts shall be certified by a type B certification in accordance with 916. The certification shall include the above three test results and the elastic section modulus value in accordance with 910.14(a)3.

Posts shall be of uniform flanged channel or U section such that the area of contact between the post and the sign is symmetrical about the vertical axis of both sign and post. The back of each post shall be formed in a manner to ensure a solid bearing surface over the entire length of the post when mounted back to back. The bearing surface on the back of the post shall be flat. The length shall be as specified with a tolerance of ∇ 25 mm (∇ 1 in.). Sign posts shall be punched with 58 holes which shall be 9.5 mm (3/8 in.) in diameter located on the center-line and spaced on 25 mm (1 in.) centers beginning 25 mm (1 in.) from the top. The remainder of the post shall be punched with 9.5 mm (3/8 in.) holes on 25 mm (1 in.) or 50 mm (2 in.) centers.

The finished posts shall be machine straightened and have a smooth uniform finish free from cracks, flaws, injurious seams, laps, blisters, and edges which are ragged, sharp, and imperfect, or other defects affecting their strength, durability, or appearance. The maximum variation in straightness shall be no more than 6 mm (1/4 in.) in any 1.5 m (5 ft) of length, or exceed in millimeters (inches) 1/4 times the number of meter (feet) of length divided by five. Bolt holes of the diameter specified shall be accurately spaced vertically and centered horizontally so that holes will register for back to back application. All holes and sheared ends shall be commercially free from burrs.

The steel sign posts shall be galvanized in accordance with ASTM A 123.

Galvanizing shall be the final process after all fabrication and punching has been completed. Posts saw cut after galvanizing shall have the cut surface treated with a zinc-based solder in rod form which complies with ASTM A 780. The cut surface shall not be treated until the fuse plate is installed and all bolts are tightened. The top of the fuse plate shall be 25 mm (1 in.) below the bottom of the sign.

Posts saw cut before galvanizing shall have temporary fasteners provided with sufficient strength to prevent warping or deforming of the post during the galvanization process. The surface under the temporary fasteners shall be treated with an approved zinc solder meeting the above mentioned specification. The surface shall be treated before the fuse plate is installed. The break-away stubs shall be galvanized a minimum of 200 mm (8 in.) below the top of the concrete foundation.

810 Steel posts shall be wired or strapped securely in bundles of not more than 907 kg (2,000 lb). They shall be nested in rows with the edges intermeshed so as to form a rectangular bundle and shall be fastened in such a manner that they do not slip or rub against each other and cause damage to the finish. Care shall be taken during shipment to prevent the bundles from rubbing against each other and causing damage. Excessive damage to the finish during shipment will be cause for rejection of the damaged posts.

820 **2. Deflection Test Requirements.** Posts will be tested as a simple beam with the flanges in compression on non-restricting supports 610 mm (24 in.) apart. Test specimens shall be 711 mm ∇ 6.3 mm (28 in. ∇ 1/4 in.) long. A load of 6672, 15569, 20462 N (1,500, 3,500 or 4,600 lb), depending on the type of post, shall be applied at the center of the span with a mandrel of not less than 25 mm (1 in.) in diameter. Application of the load shall be at a speed not to exceed 8 mm (0.3 in.) per minute. Deflection of the post upon application of the total load shall not exceed 4 mm (0.16 in.). The load shall then be removed. Deflection of the post one minute after removal of the load shall not exceed 0.25 mm (0.01 in.).

3. Type of Posts. Posts shall conform to the following table and to deflection tests required in 910.14(a)2.

Type	Minimum Elastic Section Modulus	Loading
A	.200	6672 N (1,500 lb)
B	.400	15569 N (3,500 lb)
C	.560	20462 N (4,600 lb)
Abb*	.670	**
Bbb*	1.190	**

* Back to Back

** Back to back posts shall be tested singly for deflection prior to assembly.

Note: The elastic section modulus values shall be included in the type B certification.

(b) Wide Flange Posts. Structural steel members for the support of signs shall be in accordance with AASHTO M 183 and ASTM A 709M grade 250 (ASTM A 709 grade 36). These members shall be galvanized in accordance with ASTM A 123. Base plates and stiffeners shall be in accordance with the requirements of ASTM A 709M grade 250 (ASTM A 709 grade 36). Fuse plates shall be in accordance with the requirements of ASTM A 441 and ASTM A 709M grade 345W (ASTM A 709 grade 50W) and shall be galvanized in accordance with ASTM A 123. All bolts, nuts, and washers shall be high strength and be in accordance with AASHTO M 164 and ASTM A 325.

All holes shall be drilled. All cutting shall preferably be saw cuts however flame cuts as specified in 711.13 may be allowed. Metal projecting beyond the plane of the plate face will not be allowed.

(c) Structural Steel Posts. Steel members for the support of signs shall be standard shapes as specified and shall be in accordance with 910.02(a). These members shall be galvanized in accordance with ASTM A 123. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

(d) Structural Aluminum Posts. These posts shall be standard shapes as specified and shall be aluminum in accordance with ASTM B 221M (ASTM B 221) alloy 6061-T6. Material furnished under this specification shall be covered by a type C certification in accordance with 916.

(e) Square Steel Posts. A type C certification shall be required in accordance with 916.

1. Steel. Square steel posts shall be roll formed and in accordance with one of the following:

- a. ASTM A 570, hot rolled carbon sheet steel in either 2.66 mm (0.105 in.) or 1.90 mm (0.075 in.) with a minimum yield strength of 414 MPa (60,000 psi). The ultimate tensile strength shall not exceed 550 MPa (79,800 psi) or have an elongation measured over 50 mm (2 in.) greater than 20 percent.

- 870 b. ASTM A 715, cold rolled high strength steel, 1.90 mm (0.075 in.) with a minimum yield strength of 414 MPa (60,000 psi). This shall apply to the 50 mm x 50 mm (2 in. x 2 in.) size posts only.

2. Fabrication. The posts shall be corner welded and scarfed as necessary to allow sections to telescope within each other. Cut holes or knockout holes of 11 mm (7/16 in.) diameter shall be spaced on 25 mm (1 in.) centers, on the centerlines of all four in true alignment, and opposite to each other.

3. Protective coating. The protective coating shall be applied using one of the following:

- 880 a. Both inside and outside surfaces shall be galvanized or coated in accordance with ASTM A 525.
- b. After fabrication, a triple coating system with a zinc coating in accordance with AASHTO M 120 weighing 190 mL/m² (0.60 ∓ 0.15 oz/ft²) shall be applied to the outside of the post, followed by a chromate conversion coating of 0.02 :g/mm² (15 ∓ 5 micrograms per in.²) and a clear organic exterior coating of 5 :m (0.2 ∓ 0.1 mil). The interior surface shall receive a double in-line application of a full zinc based organic coating of 30 :m (1.2 ∓ 0.6 mil). Such interior coating
- 890 shall be tested in accordance with ASTM B 117.

910.15 Delineator Posts. Posts shall be made from open hearth, basic oxygen, or electric furnace steel rolled from new billets or standard tee rails and have the mechanical and chemical properties set out for sign post in 910.14(a)1. The post shall be a uniform, modified, flanged channel or U section such that the area of contact between the post and reflector is symmetrical with the vertical axis of both reflector and post.

900 Physical requirements for steel delineator posts shall be: width of flange face 50 mm to 60 mm (2 to 2 3/8 in.); width of back 19 mm to 22 mm (3/4 to 7/8 in.); depth from face of flange to back 22 to 29 mm (7/8 to 1 1/8 in.); length 2.1 m ∓ 25 mm (7.0 ft ∓ 1 in.). Mass (Weight) of the finished post shall be not less than 1.5 nor more than 2.2 kg/m (1.0 nor more than 1.5 lb/ft).

Delineator posts shall be punched with a minimum of twenty-four 6 mm (1/4 in.) holes on the centerline spaced on 25 mm (1 in.) centers beginning 25 mm (1 in.) from the top. The finish, straightness, and coating of the delineator posts shall be in accordance with the applicable requirements of 910.14(a)1. Post with 9.5 mm (3/8 in.) holes may be used on contracts let prior to January 1, 1992.

910 **910.16 Copper Flashing.** Copper flashing shall be soft copper and shall be in accordance with ASTM B 370, except the minimum copper content shall be 99.5 percent. The mass (weight) per square meter (square foot) will be determined by weighing individual samples. If the first sample is not in accordance with the tolerances for 450 g (16 oz) sheet, two additional samples shall be tested and both shall comply with the specified tolerances. It shall withstand being bent cold through an angle of 180 degrees flat upon itself, without failure of the outside of the bent portion.

910.17 Bronze or Copper Alloy Plates. Bronze or copper alloy to be used for self lubricating bearing plates shall conform to one of the following requirements based on the design unit loading set out on the detail plans.

Design Unit Loading not over	Shall Conform to ASTM
A. 3000 psi (20684271 Pa)	B 22, Alloy C86300
B. 2500 psi (17236894 Pa)	B 100, Alloy C51000
C. 2000 psi (13789514 Pa)	B 22, Alloy C91100
D. 1000 psi (6894757 Pa)	B 22, Alloy C90500*

* Up to 2.5% lead allowed.

The sliding surfaces of the plates shall be provided with cylindrical recesses with a depth necessary to provide proper containment of the lubricant. The recesses shall be arranged in a geometric pattern so that each successive row will overlap in the direction of motion. The total area of the recesses shall comprise no less than 25 percent and no more than 35 percent of the total area of the plate.

The surface finish of bearing areas shall be in accordance with ANSI B46.1 #125. The lay of tool marks shall be in the direction of expansion or contraction of the structure. If the surface is ground, grinding knurls may be omni-directional. Flat bearing surfaces shall be flat to a tolerance of ∇ 0.0125 mm (0.0005 in.). Curved bearing surfaces shall be machined to a tolerance of ∇ 0.0005 of an inch (0.0125 mm) in each 25 mm (1 in.) of length perpendicular to the circular section. The radius of curved bearing surfaces shall have the following tolerances:

	Positive Tolerance	Negative Tolerance
Concave Surface	0.25 mm (0.010 in.)	0.000 mm (0.000 in.)
Convex Surface	0.000 mm 0.000 in.	0.25 mm (0.010 in.)

The lubricant shall be of the solid type. It shall consist of graphite and metallic substances having lubricating properties with a lubricating binder. The lubricant shall be free of any material that causes abrasive or corrosive action on the metal surfaces. It shall withstand the atmospheric elements. The lubricant shall be compressed into the recesses of the bearing plate by hydraulic pressure to form a dense non-plastic lubricating insert.

At the time of assembly in place, the steel surfaces which bear on the self lubricating bearing plate shall be lubricated with additional lubricant furnished by the manufacturer. White lead, tallow, or other coating shall be removed before the application of the lubricant.

The coefficient of friction between the self lubricating plate and the steel plates in contact with them shall not exceed 0.10 when subjected to twice the designed loading.

Material furnished under this specification shall be covered by a type C certification in accordance with 916.

910.18 Fence, Fittings, and Gates.

(a) Farm Field or Woven Wire Fence. This fence shall be in accordance with ASTM A 116. The wire shall be 3.8 mm (No. 9 gage). The design shall be 1047-6-9. The coating shall be class 3. The method of securing the vertical stays to the horizontal wires may be either of those shown on the plans. Diagonal braces shall be in accordance with 910.18(b)3.

(b) Steel Fabric Chain Link Fence. This fence shall be in accordance with ASTM A 392 for galvanized steel fabric or ASTM A 491 for aluminum coated steel fabric. The height of the fabric shall be 1.22 m (48 in.) unless otherwise specified. It shall be of 3.8 mm (No. 9 gage) wire woven in 50 mm (2 in.) mesh. The fabric shall be knuckled at the top and bottom selvages when the height is less than 1830 mm (72 in.). Fabric of 1830 mm (72 in.) in height or higher shall be knuckled at the top and shall have the twisted and barbed finish at the bottom. For galvanized fabric, coating shall be done after weaving and shall be class II, average of 2 or more specimens no less than 610 g/m² (2.0 oz/sq ft) and no less than 549 g/sq m² (1.8 oz/sq ft) for any individual specimen. For aluminum coated fabric, coating shall be class II, 122 g/m² (0.40 oz/sq ft) minimum.

The fabric shall be furnished with ties required for fastening it to the top and bottom tension wires. These fastenings may be of aluminum wire or strip of approved gage and design, or of galvanized steel wire in accordance with the manufacturer's standard design. If galvanized steel wire ties are furnished, the wire shall be no smaller than 2.7 mm (No. 12 gage). Sufficient ties shall be furnished to provide for attaching to the top and bottom tension wires each 600 mm (24 in.). Fittings necessary to make complete installation shall be pressed or rolled steel, forged steel, cast steel, or malleable iron.

Steel fabric chain link fence shall be as shown on the plans and as set out above. Twisted and barbed finish shall not be used on both the top and bottom of fabric after January 1, 1996.

1. Tension Wire. Tension wire intended for use on the top or bottom of steel chain link fence or on the bottom of farm field fence when specified shall be spring coil or crimped steel wire with an initial diameter of 0.177 ∇ 4.5 ∇ 0.1 mm), a minimum breaking load of 8.67 kN (1,950 lb), and a coating of either zinc or aluminum. The minimum mass (weight) of coating shall be 244 g/m² (0.80 oz/sq ft) for galvanized wire and 122 g/m² (0.40 oz/sq ft) for aluminum coated steel wire. The mass (weight) of aluminum coating shall be determined in accordance with ASTM A 428.

2. Stretcher Bars, Truss Rods, and Turnbuckles. Stretcher bars shall be 4.8 x 19.0 mm (3/16 by 3/4 in.) flat bars. These bars, truss rods, turnbuckles, and necessary fittings shall be of good commercial quality steel, malleable iron, or wrought iron. They shall be galvanized in accordance with ASTM A 153 after fabrication. The turnbuckles shall be made from drop forged malleable iron. They shall have a minimum take up of 100 mm (4 in.). The fittings may be pressed or rolled steel, forged steel, cast steel, or malleable iron.

3. Braces. Braces shall be made of steel pipe with bolted steel couplings or connections. Steel pipe shall be in accordance with ASTM F 1083. They shall be galvanized as set out therein. Fabrication or manipulation that causes minor damage to the galvanized coating shall be corrected by approved application of a high zinc dust-zinc oxide paint

conforming to the requirements of Federal Specification TT-P-641 type II or Military Specifications DOD-P-21035. When spray paints are used, two coats shall be applied. Damaged braces will be rejected.

1010 **4. Barbed Wire.** Barbed wire used at the top and bottom of farm field fence, or as otherwise specified, and in accordance with 603 shall be in accordance with applicable provisions of ASTM A 121. It shall be composed of 2.5 mm (No. 12 1/2 gage) galvanized or aluminum coated steel wire with four round 2.0 mm (14 gage) barbs at approximately 125 mm (5 in.) spacing. The galvanized coating shall be in accordance with class 3 in Table 3. The minimum aluminum coating mass (weights) shall be 91.5 and 76.3 g/m² (0.30 and 0.25 oz/sq ft) on the 2.5 mm (12 1/2 gage) wire and 2.0 mm (14 gage) barbs respectively. The mass (weight) of coating shall be determined in accordance with ASTM A 428. The use of aluminum barbs, in accordance with ASTM B 211M (ASTM B 211), alloy 5052-H38, nominal diameter 2.0 mm (0.080 in.), will be permitted.

1020 The use of barbed wire with 1.7 mm (No. 15 1/2 gage), high tensile strength line wires, and 1.5 mm (No. 16 1/2 gage) barbs will be permitted. The barbs shall be round with four points and spaced at approximately 125 mm (5 in.) intervals. The barbed wire shall be in accordance with ASTM A 121, except the minimum mass (weight) of zinc coating shall be 229.0 g/m² (0.75 oz/sq ft) for line wires and 214.0 g/m² (0.70 oz/sq ft) for barbs.

(c) Aluminum Fabric Chain Link Fence. This fence shall be in accordance with the applicable requirements of 910.18(b) except for composition of materials. Requirements for the various component parts of aluminum fence shall be as shown in Table I.

TABLE 1

ITEM	ASTM REFERENCE	ALLOY	ADDITIONAL INFORMATION
Fabric	B 211M (B 211)	Alclad 5056 or 6061-T94	
Barbed Wire - Line	B 211M (B 211)	5062-0, H38 or 6061-T89	2-strand dia. 2.8 mm (0.110 in.) 4-pt. barb. dia. 2.0 mm (0.080 in.) 127.0 mm (5 in.) space
- Barbs	B 211M (B 211)	5052-H38	
Tension Wire	B 211M (B 211)	Alclad 5056 or 6061-T94	Dia. 4.9 mm (0.192 in.); Note 1
Hog Ring Fasteners	B 211M (B 211)	6061-T94	Dia 2.8 mm (0.110 in.)
Wire Ties	B 211M (B 211)	1100-H18	Dia. 3.8 mm (0.148 in.)
Flat band ties	B 211M (B 211)	3003-H14	12.7 mm (1.2 in.) wide; 1.5 mm (0.06 in.) thick
Stretcher Bars	B 211M (B 211)	6063-T6	19.0 mm (3/4 in.) by 6.4 mm (1/4 in.); square edges
Truss and Brace Rods	B 211M (B 211) or B 221M (B 221)	6061-T6	Dia. 9.5 mm (3/8 in.)
Turn Buckles	B 26M (B 26) (cast parts), B 211M (B 211) (wrought)	356.0-T6 6061-T6	
Bands	B 221M (B 221)	6063-T6	3.2 mm (1/8 in.) by 25 mm (1 in.) beveled edge
Bolts	B 211M (B 211) or B 221M (B 221)	2024-T4	ASA B18.2 hexagon threads class 2, 2A, or 2B
Nuts	B 211M (B 211) or B 221M (B 221)	6061-T6	
Expansion Sleeves	B 210M (B 210)	3003-H18	43.1 mm (1.695 in.) ID by 1.98 mm (0.078 in.); wall drawn type. 152 mm (6 in.) long; self centering
Post Tops, Rails and Brace Ends	B 26M (B 26) or B 108	356.0T6	Fabricated in permanent molds or sand castings
Top and Brace Rails	B 241M (B 241) and B 429	6063-T6	31.8 mm (1 1/4 in.) pipe; Note 2
Barbed Wire Extension Arms	B 26M (B 26) or B 108	356.0T6	Fabricated as for post tops; sheet castings
Line Posts	B 241M (B 241) and B 429	6063-T6	50 mm (2 in.) pipe; Note 2
Corner Posts	B 241M (B 241) and B 429	6063-T6	63 mm (2 1/2 in.) pipe; Note 2

Note 1: Aluminum coated steel wire in accordance with 910.18(b) may be used.

Note 2: ANSI schedule 40 pipe, plain ends.

(d) Gates. Gate post sizes shall be as follows:

ANSI Nominal pipe	Swing gate opening, (inclusive)	
Size	Single gate	Double gate
64 mm (2 1/2 in.)	up to 1.83 m (6 ft)	up to 3.66 m (12 ft)
89 mm (3 1/2 in.)	2.13 m to 3.96 m (7 to 13 ft)	3.96 m to 7.92 m (13 to 26 ft)
152 mm (6 in.)	4.27 m to 5.49 m (14 to 18 ft)	8.23 m to 11.28 m (27 to 36 ft)
203 mm (8 in.)	5.79 m to 9.75 m (19 to 32 ft)	11.27 m to 19.51 m (37 to 64 ft)

1040 **1. Steel Gates.** Steel gate posts shall be standard weight, galvanized, steel pipe in accordance with ASTM F 1083 and furnished with all necessary fittings. Post sizes shall be as set out above. The gate frames shall be of standard mass (weight), galvanized, steel pipe in accordance with ASTM A 120; of 38.1 mm (1 1/2 in.) nominal size; and shall have welded joint or riveted construction using galvanized pressed steel or malleable fittings. Areas welded after galvanizing shall be coated with a material conforming to the requirements of Federal Specification TT-P-641, type II, or Military Specification DOD-P-21035. When spray paints are used, two coats shall be applied. Fabric coverings for gates shall be in accordance with 910.18(a) or 910.18 (b). These gates shall be furnished with necessary fastenings, hinges, center stops, and locking devices galvanized after fabrication in accordance with ASTM A 153.

1050 **2. Aluminum Gates.** Aluminum gate post sizes shall be in accordance with 910.18(d). They shall be ANSI schedule 40 pipe and in accordance with ASTM B 241M (ASTM B 241) or B 429, alloy 6063-T6. Gate frames shall consist of 38 mm (1 1/2 in.) schedule 40 pipe assembled by welding and/or with fittings. Pipe shall be in accordance with ASTM B 241M (ASTM B 241) or B 429, alloy 6063T6. Welding material and procedures shall be in accordance with the applicable AWS provisions. Formed sheet fittings shall be in accordance with ASTM B 209M (ASTM B 209), alloy 6061-T6. Gate hinges may be offset type wrought aluminum, ASTM B 209M (ASTM B 209), alloy 6061-T6, or galvanized malleable iron. Fabric shall be in accordance with 910.18(c).

(e) Control Procedures for Furnishing Fence and Accessories.

1060 **1. General Requirements.** All fence and accessory materials shall be subject to the control procedures set out herein. The control procedure methods which may be used are as follows:

- a. Suppliers qualified to furnish pretested approved stockpiled material.
- b. Suppliers not qualified or not desiring to furnish pretested approved stockpiled material.

1070 **2. Suppliers of Pretested Approved Stockpiled Material.** Suppliers desiring to furnish pretested approved stockpiled material shall contact the District Materials and Tests Engineer. A written request will not be required.

 The requirements set out in the General Procedures for Controlling Materials Approved Prior to Delivery to the Project will apply with the following additions, modifications, or clarifications.

- 1080 a. Posts, braces, or similar pieces shall be bundled before or after sampling, but prior to approval.
- b. All tests will be performed at the Division of Materials and Tests.
- c. Basis of acceptance will be a car seal attached to each roll of fence, barbed wire or tension wire, and each bundle of posts. Acceptance numbers will not be issued for accessories such as posts caps, brackets or tie wires.
- d. If a complete roll or bundle is not shipped, the car seal shall be retained with the unused portion. The number shall be supplied to the Engineer for the material acceptance.

1090 **3. Suppliers Not Furnishing Pretested Approved Stockpiling Material.** Suppliers not desiring to retain status or who lose status to furnish pretested stockpiled material will have their material inspected at the project site after delivery. No material may be used until it has been tested and approved.

1100 **910.19 Overhead Sign Structures.** The complete structure with signs in place shall be able to withstand wind pressure in accordance with AASHTO specifications for the Design and Construction of Structural Supports for Highway Signs. The structure shall be designed to resist movement by the wind which might contribute to the fatigue of the material.

 All prefabricated structural units shall be packed so that there is no injury or defacement during transportation to the point of destination.

 All bolts, nuts, and washers for bridge bracket assemblies shall be stainless steel in accordance with ASTM F 738M.

1110 Strain poles for cable span signs shall be in accordance with 913.15(e)1. Each strain pole shall include three band type attachments for span wire clamps. Such attachments shall be galvanized in accordance with ASTM A 153. Cable shall be in accordance with 913.15(f)2. Each cable shall include three wire rope clips at each end. Anchor bolts shall be in accordance with 913.15(e)1a. All sign mounting hardware except for the extruded aluminum bar shall be galvanized in accordance with ASTM A 153.

 Material furnished under this specification shall be covered by a type C certification in accordance with 916.

(a) Aluminum Overhead Sign Structures, Box Truss and Bridge Attached.

1120 Extruded tubes shall be of aluminum in accordance with ASTM B 221M (ASTM B 221), B 241M (B 241), or B 429, alloy 6061-T6. Anchor base castings shall be of aluminum in accordance with ASTM B 26M (ASTM B 26) or B 108, alloy 356.0-T6. All other castings shall be of aluminum in accordance with ASTM B 26M (ASTM B 26), alloy 356.0-T6. Plates shall be aluminum in accordance with ASTM B 209M (ASTM B 209), alloy 6061-T6. Plates shall be free of sharp edges and irregularities.

Welding material and procedures shall be in accordance with applicable AWS provisions.

1130 Bolts, nuts, screws, and flat washers shall be passivated type 304 stainless steel. Bolts and screws shall be in accordance with ASTM A 193M (ASTM A 193), grade B8. Hexagon nuts and washers shall be in accordance with ASTM A 194M (ASTM A 194), grade 8.

Anchor bolts shall be in accordance with ASTM A 307. A hexagon nut, leveling nut, and flat washer in accordance with ASTM A 307, grade A, shall be furnished with each anchor bolt. Threaded ends of anchor bolts and associated hardware shall be coated in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C.

1140 Certified proof of the qualifications for a minimum of two welders shall be presented after the contract is awarded and before fabrication is started. This certification shall be from a commercial or public testing laboratory and qualifications shall be based on welding of aluminum alloy, 6061-T6 with consumable electrode type welding using aluminum alloy ER4043 filler material. Welders shall qualify by passing the requirements of "Procedure and Performance Tests of Qualification Standard for Welding Procedures, Welders, and Welding Operations," latest edition, formulated by the Boiler and Pressure Vessel Committee of the American Society of Mechanical Engineers.

1150 Welding shall be checked carefully by visual inspection. Poor welding workmanship as noted by visual inspection shall be sufficient cause for rejection.

Each complete structure shall be warranted that it is free from any misfits or structural deficiencies prior to shipment.

(b) Steel Overhead Sign Structures, Box Truss, Cantilever, Monotube, and Bridge Attached. Steel sections used for upright members, cross beams, or horizontal members shall be either tapered or constant cross section tubular members as specified herein. The tubular members may be either circular or multi-sided.

1160 Box truss and bridge attached structures shall be fabricated from constant cross section tubular steel in accordance with to ASTM A 53, type E or S, grade B. Constant cross section tubular steel with greater yield strength may be used, with written approval. However, structural dimensions must remain as shown in the plans. Structures shall be galvanized after fabrication in accordance with ASTM A 123.

1170 Tri-cord truss, cantilever, and monotube structures shall be made of tapered tubular members in accordance with either ASTM A 595 or ASTM A 572M (ASTM A 572), grade 50, or of constant cross section tubular members in accordance with API High Test Line Pipe, grade X-52. Members shall have a minimum yield strength of 345 MPa (50,000 psi). Structures shall be galvanized after fabrication in accordance with ASTM A 123.

Strain poles shall be anchor bolt type complete with hand-holes and pole top or cap. They shall meet the requirements set out above for cantilever sign structures. Each pole is to include 3 band type attachments for span wire clamps. The band shall be from material in accordance with ASTM A 572M (ASTM A 572), grade 50; ASTM A 606; or approved equal. The bands shall not be of the U-bolt type. The poles shall have maximum deflections as shown below when loaded 450 mm (18 in.) from the top with a 445 N (100 lb) load:

	Pole Size	Deflection
1180	380 mm x 910 mm (15 in. x 30 in.)	4.1 mm (0.16 in.)
	356 mm x 790 mm (14 in. x 26 in.)	3.0 mm (0.12 in.)

1190 The steel flanges at the center of the cross beam and at the ends of the horizontal arms shall be fastened to the tapered or straight sections by means of two circumferential welds. One of the circumferential welds shall weld the outside of the flange firmly to the tube. The flange connection shall develop fully the strength of the tubular sections being joined together by means of the flange connections.

1200 Gusset, flange, and base plates shall be in accordance with ASTM A 36M (ASTM A 36) and shall be galvanized after fabrication in accordance with ASTM A 123. Base plates for upright poles shall develop the full strength of the poles. Castings for the vertical pole top and horizontal arm and cap shall be in accordance with ASTM A 126 and shall be galvanized with a minimum coating of 610.0 g/m² (2 oz/sq ft). Bolts, except anchor bolts, and nuts shall be in accordance with ASTM A 307. Two nuts for use in plumbing upright poles shall be furnished with each anchor bolt. Anchor bolts, except for box truss structures, shall be in accordance with ASTM A 675M (ASTM A 675), grade 90; ASTM A 576 modified to 379 MPa (55,000 lb/sq in.) minimum yield strength; or ASTM A 307, grade A modified to 379 MPa (55,000 pounds per square inch) minimum yield strength. Anchor bolts for box truss structures shall be in accordance with 910.19(a). Steel bolts, nuts, washers, and threaded ends of anchor bolts shall be coated in accordance with ASTM A 153 or be mechanically galvanized and conform to the coating thickness, adherence, and quality requirements of ASTM A 153, class C. Welding shall be in accordance with 711.32.

1210 Beam clamp details and sign support assemblies shall be galvanized in accordance with ASTM A 153. Clamps shall be fabricated of high strength, low alloy steel in accordance with ASTM A 242M (ASTM A 242), ASTM A 606, or approved equal. Stainless steel U-bolts may be used in lieu of the clamps for the attachment of the sign hangers to the arms of double arm cantilevers. The U-bolts shall be in accordance with 909.19(a) for stainless steel hardware.

910.20 Blank.

910.21 Steel Sheet Piling. Steel sheet piling shall be in accordance with ASTM A 328M (ASTM A 328), ASTM A 569M (ASTM A 569), or ASTM A 525M (ASTM A 525).

SECTION 911 -- WOOD MATERIALS

911.01 Untreated Lumber.

(a) General. Untreated lumber is a saw mill product which is not further manufactured than by sawing, resawing, passing lengthwise through a standard planing machine, cross cutting to length, and machining but is not treated with preservatives.

10 All lumber to be used without preservative treatment shall have the heart center completely boxed in pieces 150 mm (6 in.) and over in thickness. Pieces not large enough to box the center shall be cut outside the heart. Stringers, floor beams, and flooring shall have no less than 80 percent of heart on any girth. Caps, sills, and posts shall have no less than 60 percent of heart on each of the four sides measured across the side. Bracing, struts, rails, and such shall have no less than 80 percent on both sides measured across the side. If plans or purchase order are marked "Square Edge" no wane will be permitted.

1. Boards. Yard lumber less than 50 mm (2 in.) thick and more than 25 mm (1 in.) wide is a board.

20 **2. Dimension Lumber.** Lumber from 50 mm (2 in.) to but not including 125 mm (5 in.) thick and 50 mm (2 in.) or more wide is dimension lumber.

3. Structural Lumber. Lumber that is 50 mm (2 in.) or more thick and 100 mm (4 in.) or more wide intended for use where working stresses are required is structural lumber. The grading of structural lumber is based on the strength and use of the entire piece. Joists and planks shall be structural lumber. Dimensions and grade of lumber shall be as shown on the plans or as otherwise specified.

30 **4. Timbers.** Lumber of 125 mm (5 in.) or more in the least dimension is timber. Timbers may be classified as beams, stringers, posts, caps, sills, girders, purlins, etc. Timber for structural purposes shall be no less than 150 mm (6 in.) in width or thickness. Dimensions and grade of lumber shall be as shown on the plans or as otherwise specified.

5. Timbers, Round. These timbers are used in the original round form, such as poles, posts, and mine timbers. Round timbers, such as posts and poles, shall be entirely peeled. All limbs and knots shall be trimmed flush. Unless otherwise permitted or shown on the plans, no minus tolerances will be permitted on the specified diameter.

40 **6. Yard Lumber.** Lumber of all sizes and patterns that is intended for general building purposes is yard lumber. The grading of yard lumber is based on the intended use of the particular grade and is applied to each piece with reference to its size and length when graded without consideration to further manufacture.

7. Surfaced or Dressed Lumber. This is lumber that is dressed by running it through a planer.

8. Rough Lumber. Lumber as it comes from the saw is rough lumber.

50 **(b) Species and Grade.** Only coast region douglas fir, red oak group, redwood,
long or short leaf southern yellow pine, and white oak group will be permitted, except as set
out elsewhere herein. Redwood lumber shall not be used in bridges where it is a permanent
part of the structure.

Except as otherwise provided, all lumber furnished under these specifications shall
be of the species and grades specified.

60 Softwood lumber shall be graded in accordance with grade rules which conform
with the basic provisions of the American Softwood Lumber Standard PS20-70. It shall be
grade marked and shall be in accordance with the applicable grading rules or specifications
of the following agencies for the species indicated:

Coastal Region Douglas Fir-West Coast Lumber Inspection Bureau

Southern Yellow Pine-Southern Pine Inspection Bureau

Redwood-Redwood Inspection Service

70 Red and White Oak Group, Hardwood Lumber, shall be grade marked and shall be
in accordance with the applicable grading rules of the National Hardwood Lumber
Association.

If lumber is not to be graded as provided above, it may be green or seasoned, but
shall be sound, free from excessive wane, unsound loose or hollow knots, knot holes,
shakes, or other defects which would impair strength or durability for the use intended. Pin
holes, shot holes, or occasional grub holes in oak are not classified as defects. If approved
and if the proposed use of the material is stated on the purchase order, grade markings may
not be required on native red or white oak groups furnished from local sources or on
emergency orders or small orders of douglas fir and southern yellow pine.

80 Lumber for temporary bridges or other temporary structures may be of any species
and grade which meets approval.

(c) Inspection. All lumber regardless of grade markings may be inspected for
grades and quality at the point of origin or final destination. If, during inspection of a lot of
lumber, it becomes apparent that the quantity of rejections exceed 20 percent, the entire lot
may be rejected.

90 **(d) Tolerances.** Tolerances for rough sawed, or dressed lumber shall be in
accordance with the following table.

Nominal Dimensions		Rough Lumber Tolerances*		Surfaced Lumber Tolerances (SIS and S2S to S4S)	
Thickness mm (in.)	Width mm (in.)	Thickness mm (in.)	Width mm (in.)	Thickness mm (in.)	Width mm (in.)

25 (1)	under 203 (8) 203 (8) and over	3 (1/8) 3 (1/8)	6 (1/4) 10 (3/8)	6 (1/4) 6 (1/4)	10 (3/8) 13 (1/2)
50 (2)	under 200 (8) 203 and over (8)	6 (1/4) 6 (1/4)	6 (1/4) 10 (3/8)	10 (3/8) 10 (3/8)	10 (3/8) 13 (1/2)
Over 50 (2) but less than 203 (8)	under 203 (8) 203 and over (8)	6 (1/4) 6 (1/4)	6 (1/4) 10 (3/8)	10 (3/8) 10 (3/8)	10 (3/8) 13 (1/2)
203 (8) and over	203 (8)and over	10 (3/8)	10 (3/8)	13 (1/2)	13 (1/2)

* If full size rough lumber is specified, no minus tolerances will be permitted.

(e) Untreated Piling. Untreated piles shall be cut from white or red oak, dense southern yellow pine, fir, or cypress, preference given in the order named. Subject to approval, they may be of other species which can withstand driving without showing excessive brooming or splitting.

100 All piling shall have been cut from sound, solid, live trees. They shall contain no ring shakes, dote, or unsound knots. Sound knots will be permitted provided the diameter of the knot does not exceed 100 mm (4 in.) or 1/3 of the diameter of the pile where it occurs, whichever is the smaller. Any defects, or combination of defects, which impair the strength of the pile will not be permitted. The piles shall be free from twist of grain exceeding 1/2 of the circumference in any 6.1 m (20 ft) of length. The butts shall be sawed square and the tips sawed square or tapered to a point of not less than 10 300 mm² (16 in.) with the tip so formed that the centerline of the pile passes through the tip.

110 Unless otherwise specified, all piles shall be peeled before driving by removing all the rough bark and at least 80 percent of the inner bark. No strip of the inner bark remaining on the pile shall be more than 19 mm (3/4 in.) wide and there shall be at least 25 mm (1 in.) of barkfree surface between any two such strips. Not less than 80 percent of the surface on any one circumference shall be clean wood. Piles shall be cut above the ground swell, and shall have a uniform taper from butt to tip. All knots shall be trimmed flush with the body of the pile.

120 A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than one percent of the length of the pile. In short bends, the distance from the center of the pile to a line stretched from the center of the pile above the bend to the center of the pile below the bend shall not exceed 4 percent of the length of the bend, but in no case more than 63 mm (2 1/2 in.). Piles shall be free from reverse bends.

After peeling, piles shall have diameters as indicated below unless otherwise approved or required.

Length of Pile	Diameter - Inches (mm)		
	Tip Minimum	3' from Butt Minimum (0.9 m)	Butt Maximum
Less than 6.1 mm (20 ft)	203 (8)	279 (11)	508 (20)
6.1 m (20 ft) and less than			

12.2 m (40 ft)	203 (2)	305 (12)	508 (20)
12.2 m (40 ft) and less than 18.3 m (60 ft)	178 (7)	330 (13)	508 (20)
18.3 m (60 ft) and more	152 (6)	330 (13)	508 (20)

911.02 Treated Lumber.

(a) **General.** Treated lumber shall be lumber which is preservative treated by pressure processes in accordance with the AWPAs Standards. AWPAs Standard C1 specifies general requirements for all wood products. Other AWPAs Standards applying to specific items are set out in 911.02(b), 911.02(c), 911.02(d), and 911.02(e). Lumber to be treated shall be in accordance with 911.01, except as modified in 911.02(b) 911.02(c), 911.02(d), and 911.02(e). The lumber may be inspected at the treating plant. Preservatives shall be in accordance with 911.02(f).

(b) **Bridge Lumber.** This shall be southern yellow pine or coast region douglas fir, there shall be no heartwood requirements and the amount of sapwood shall not be limited. Wane will not be permitted on any treated plank for flooring and may be excluded elsewhere when so specified. In other lumber, wane shall not exceed 1/8 of the width of any face and 1/4 of the length of the piece on any one corner. Both the outer and inner bark shall be removed from any area where wane is permitted. Lumber for bridges shall be treated with a preservative in accordance with applicable provisions of Standard C14 and C2 of the AWPAs Standards.

(c) **Piling.** Wood piling, before treatment, shall be in accordance with 911.01(e) except piles shall be southern yellow pine, red oak, or coast region douglas fir. The outer and inner bark shall be removed before treatment. Unless otherwise specified, piling shall be treated with creosote in accordance with the applicable provisions of Standards C14 and C3 of the AWPAs Standards.

(d) **Guardrail Posts, Braces, and Battens.** Wood for these items shall be cut from live, dense southern yellow pine, coast region douglas fir, red oak, or other species if so designated in the proposal or purchase order. Posts shall be rough sawed unless otherwise specified. Dimensions shall be as shown on the plans. There shall be a length tolerance of plus 50 mm (2 in.) for posts. The bottoms shall be sawed square and the tops roofed as shown on the plans. Wane shall not extend more than 0.6 m (2 ft) from the bottom end. Knots shall be closely trimmed, but hollow knots extending in close to the center of the post, loose knots, and knot clusters will not be permitted. Posts shall be practically straight and no post with a crook exceeding 25 mm (1 in.) between top and butt will be accepted.

Posts listed above shall be sound posts. No sapwood rot will be permitted. Ring shake will not be permitted and oak posts shall be free from pecks or excessive grub holes. Grub holes in the butt, 13 mm (1/2 in.) or less in diameter, are not considered defects. Posts containing ant holes will not be accepted. Any post which contains any defect which is detrimental to the post will be rejected.

Wood braces and battens shall be of the same general species and specifications as required for the posts and shall be of the dimensions shown on the plans.

170 Wood guardrail posts, and wood parts in connection with guardrails, shall be treated with a preservative in accordance with the applicable provisions of Standards C14 and C2 of the AWP Standards.

(e) **Sign Posts.** Wood sign posts shall be cut from live catalpa; northern white cedar; native red cedar; southern red cedar; black locust; yellow locust; mulberry; red, black, and white oak group; osage orange; dense southern yellow pine; redwood; sassafras; coast region douglas fir, or other species as specified. Posts shall be surfaced 4 sides.

180 Dimensions shall be in accordance with the plans. There shall be a length tolerance of 50 mm (2 in.). Both butt and top ends shall be sawed square. All outer and inner bark shall be removed. One way sweep, not exceeding 25 mm (1 in.) between the top and the butt, will be acceptable. Short crooks will not be permitted.

The posts shall be sound timber. No splits, shakes, excessive cracks, loose decayed or hollow knots will be permitted. Occasional pin, shot, or grub holes in oak, or bird pecks in other timbers, will not be considered defects. All posts shall be entirely treated with preservatives in accordance with all applicable provisions of Standards C14 and C2 of the AWP Standards. The oil carrier shall be a heavy petroleum solvent in accordance with the applicable provisions of Standard P9 of the AWP Standards and shall be of such characteristics that the posts will be suitable for painting with an oil base paint.

190 (f) **Sawed Timber Posts and Blocks for Thrie-Beam and W-Beam Guardrail.** The requirements for posts and blocks prior to treatment shall be as shown below.

200 **1. Species and Grades.** Wood posts shall be of the species listed, and shall be in accordance with the grading requirements specified in Table A. Wood blocks shall be of the species listed, and shall be in accordance with the grading requirements specified in Table B. Wood posts and blocks shall have a nominal cross section and dimensions as shown on the plans.

TABLE A

SPECIAL AND GRADING REQUIREMENTS FOR SAWED TIMBER GUARDRAIL POSTS		
SPECIES	POSTS & TIMBERS GRADE	GRADING RULES AGENCIES ^a
HARDWOODS		
Red Oak (Northern Red, Black, Pin, Laurel, Cherry-Bark, Scarlet, Water and Willow Oaks) ^b , Hard Maple (Black & Sugar) and Red Maple White Ash White-Heartwood Beech Yellow Birch Hickory (Mockernut, Pignut, Shagbark, and Shellbark Hickories)	Grade GRP	Department
SOFTWOODS		
Douglas Fir, Douglas Fir-Larch Southern Pine Jack Pine 200 mm x 200 mm (8 in. x 8 in.)	No. 1 or better No. 1 or better No. 1 or better	WWPA or WCLIB SPIB NHPMA

^a NHPMA (Northern Hardwood and Pine Manufacturers Assoc.); WWPA (Western Wood Products Assoc.); WCLIB (West Coast Lumber Inspection Bureau); and SPIB (Southern Pine Inspection Bureau).

^b Southern Red Oak will not be permitted.

Posts and blocks shall be graded in accordance with grading rules based on principles and methods specified in ASTM D 245. Where there is a conflict between AWP and ASTM standards, AWP will prevail. Where there is a conflict between either AWP or ASTM standards and this specification, this specification will prevail.

All material shall show the approved grading agency stamp indicating mill origin, species, and grade.

TABLE B

SPECIES AND GRADING REQUIREMENTS FOR SAWED TIMBER GUARDRAIL BLOCKS		
SPECIES	POSTS & TIMBERS GRADE	GRADING RULES AGENCIES
HARDWOODS		
Red Oak (Northern Red, Black Pin, Laurel, Cherry-Bark, Scarlet, Water and Willow Oaks) ^b , Hard Maple (Black & Sugar) and Red Maple, White Ash, White-Heartwood, Beech, Yellow Birch Hickory (Mockernut, Pignut, Shagbark, and Shellbark Hickories)	Grade GRP	Department
SOFTWOODS		
Douglas Fir, Douglas Fir-Larch Southern Pine Species Jack Pine, Red Pine, and Eastern White Pine (Northern White Pine)	No. 2 or better No. 2 or better No. 1 or better.	WWPA or WCLIB SPIB NHPMA

^a NHPMA (Northern Hardwood and Pine Manufacturers Assoc.); WWPA (Western Wood Products Assoc.); WCLIB (West Coast Lumber Inspection Bureau); and SPIB (Southern Pine Inspection Bureau)

^b Southern red oak will not be permitted

2. Department Grade GRP. The requirements for posts to be in accordance with the Department's Grade GRP, Guardrail Posts, will be as follows:

a. Splits. Splits in the plane of the bolt hole shall not exceed 75 mm (3 in.). At other locations, splits shall not exceed 150 mm (6 in.).

b. Checks. Single checks shall not be greater than 75 mm (3 in.) deep. Checks opposite each other shall not total more than 75 mm (3 in.) deep, as measured with a probe that is not more than 1.6 mm (1/16 in.) in thickness or in diameter.

Single checks of 6 mm (1/4 in.) wide, or wider, measured at the widest point, shall not extend more than one third of the length of the post. Single checks, measured at the widest point, shall not exceed 10 mm (3/8 in.) in width.

c. Shakes. Shakes, measured in the least dimension, shall not exceed 50 mm (2 in.).

Splits, checks, and shakes shall not be in combinations which may cause the post to separate into several pieces.

d. Stains. Stained heartwood, not caused by decay, shall not exceed 25 percent of the piece.

e. Slope of Grain. Slope of grain shall not exceed 1 in 10.

f. Wane. Wane shall be less than one quarter of each face.

g. Knots. Knots shall be sound and tight. The sum of the least dimensions of all knots in a 150 mm (6 in.) length of post, all faces, shall be less than 125 mm (5 in.). Grain distortion caused by knot clusters shall not exceed 63 mm (2 1/2 in.). Knots will be permitted on all faces, but knots shall not exceed 63 mm (2 1/2 in.) in the least dimension.

250

3. Department Grade GRB. The requirements for blocks to be in accordance with the Department's Grade GRB, Guardrail Blocks, will be as follows:

a. Splits. Splits in the plane of the bolt hole shall not exceed 75 mm (3 in.). At other locations, splits shall not exceed 125 mm (5 in.).

b. Checks. Checks shall be in accordance with 910.02(f)2b.

260

c. Shakes. Shakes, measured in the least dimension, shall not exceed 75 mm (3 in.). Shakes shall not extend beyond half the standard grading length of the piece.

Splits, checks, and shakes shall not be in combinations which may cause the block to separate into several pieces.

d. Stains. Stained heartwood, not caused by decay, shall not exceed 25 percent of the piece.

e. Wane. Wane shall be less than one third of each face.

270

f. Knots. Grain distortion caused by knot clusters shall not exceed 100 mm (4 in.). Knots will be permitted on all faces, but knots shall not exceed 100 mm (4 in.) in the least dimension.

4. General Requirements. Posts and blocks shall be in accordance the following general requirements.

a. Decay. Posts and blocks shall be free from decay before treatment.

280

b. Unsound Wood. Posts containing unsound wood will be rejected. Blocks may contain small spots of unsound wood provided they are well scattered.

c. Crook or Bow. Crook or bow shall not exceed 25 mm per 3 m (1 in. per 10 ft) length.

d. Dimensional Tolerances. Posts and blocks shall be sawed square to within -13 mm (-1/2 in.) of the specified cross-sectional dimensions. A tolerance of -5.8 mm (-2 in.) will be permitted on the specific length of the posts. A tolerance of -13 mm (-1/2 in.) will be permitted on the specified length of the blocks.

290

5. Pressure Treating Posts and Blocks. Pressure treating posts and blocks shall be in accordance with the following requirements.

a. Machining. Posts and blocks shall be sawed to their final shape and holes bored prior to treatment.

b. Blank.

300 **c. Inspection Before Treatment.** The treater shall be responsible for ensuring that the material has the required approved grading agency stamp before treatment is commenced. The stamp or marking shall be applied on a wide face at the trimmed end. The stamp shall be applied such that it remains readable after treating. Material that has been air dried or kiln dried shall be inspected for moisture content as specified below, in accordance with AWPAs Standard M2. Tests of representative pieces shall be conducted. The minimum number of tests shall be the lesser of five percent or 50 pieces out of a charge.

310 **d. Test for Moisture Content.** The test shall be made with an electrical resistance type moisture meter with insulated needles of 38 mm (1.5 in.) in length. The readings shall be corrected for species and temperature readings in accordance with the meter instructions. The readings shall be taken on one surface at mid-length with needles driven to their full length. The lot will be considered acceptable when the average moisture content does not exceed 19 percent. Individual pieces exceeding 23 percent moisture content will be rejected. Such pieces shall be removed from the lot.

e. Preservative Treatment. All posts and blocks shall be treated with a preservative as specified herein.

320 **f. Material for Preservative Treatments.** The preservative used for treating posts and blocks shall be in accordance with the appropriate AWPAs standards listed in Table C.

TABLE C

MATERIAL	AWPA Standard
Ammoniacal Copper Arsenate (ACA)	P5
Ammoniacal Copper Arsenate (ACZA)	P5
Chromated Copper Arsenate (CCA)	P5

g. Treatment Methods. Wood for guardrail posts and blocks shall be treated to be in accordance with AWPAs Standards C1 and C2, ASTM D 1760, and the requirements specified herein.

330 **h. Sorting and Spacing.** The material in a charge shall consist of the same species or consist of species within one group shown in Table D. The material shall have similar moisture content and be of similar form and size. Blocks and posts may be treated in the same charge.

Pieces in the charge shall be separated by horizontal stickers so that preservative and steam, if used, shall contact all horizontal surfaces.

TABLE D

SPECIES GROUPINGS FOR TREATMENT IN SAME CHARGE	
GROUP	SPECIES
A	Southern Pine
B	Douglas Fir
C	Jack Pine*
D	Hardwoods

* Also Red Pine and Eastern White Pine Blocks

340 **i. Conditioning.** Material may be conditioned by means air seasoning, kiln drying, Boulton drying, vapor drying, steaming, or heating in preservative except as limited herein. Material which is air seasoned or kiln dried shall have an average moisture content not exceeding 19 percent before treatment. When steam conditioning, the maximum temperature shown in Table E shall not be reached in less than one hour. If a vacuum is applied after steaming, it shall be a minimum of 560 mm (22 in.) of mercury. In addition, when using CCA, ACA, or ACZA, material shall be removed from the cylinder and permitted to cool to 49EC (120EF), or below, after steaming and before the preservative is applied. When treating douglas fir with pentachlorophenol, steaming will not be permitted. When treating southern pine, jack pine, and red pine with CCA, ACA, or ACZA, steaming will only be permitted to thaw frozen or ice coated material.

350 When conditioning by heating in preservative, the solution shall cover the material. Maximum temperatures permitted shall be those shown in Table E. Conditioning by means of heating in water-borne preservatives CCA, ACA, or ACZA will not be permitted.

TABLE E

CONDITIONING METHODS PERMITTED AND TEMPERATURE REQUIREMENTS FOR METHOD USED					
		HEATING IN			
		STEAMING		PRESERVATIVE	
SPECIES	CONDITIONING METHODS PERMITTED	Max.Temp EC (EF)	Max. Duration Hrs	Max.Temp EC (EF)	Max. Duration Hrs
Hard Maple	Air drying only				
Other Hardwoods ⁽¹⁾	No Steaming			104 (220)	No Limit
Southern Pine	Shown in 901.02(f)5i	118 (245)	17	104 (220)	No Limit
Eastern White Pine	All	116 (240)	4 1/2	99 (210)	6 (3)
Other Softwoods ⁽²⁾	Shown in 910.02(f)5i	116 (240)	6	99 (210)	6 (3)

j. Treatment. Material shall be treated by such processes and under such conditions as to achieve the retentions and the penetrations specified below.

360 Pressure shall be increased to at least the minimum but not higher than the maximum levels given in Table G and shall be maintained until the desired volume of preservative has entered the wood. The temperature of the preservative during the entire pressure period shall not exceed the maximum temperatures shown in Table F.

TABLE F

MAXIMUM TEMPERATURE OF THE PRESERVATIVE DURING THE ENTIRE PRESSURE PERIOD	
MATERIAL	Max. Temp. EC (EF)
Ammoniacal Copper Arsenate (ACA)	66 (150)
Chromated Copper Arsenate (CCA)	49 (120)
Ammoniacal Copper Zinc Arsenate (ACZA)	66 (150)

370 **k. Inspection During Treatment.** The treater shall determine that the preservatives used are in accordance with the requirements herein. The minimum frequency of the preservation analyses shall be each charge for the occasional single charge inspected. The minimum frequency for consecutive treatments from the same working tank shall be the first and at least one of every five additional charges, selected at random. Preservative samples shall be taken as appropriate so as to be representative of the solution in the treating cylinder.

l. Retentions. The minimum retentions in kg/m³ (lb/cu ft) for the outer 15 mm (0.6 in.) of guardrail posts and blocks shall be those listed in Table H. Retentions shall be determined by chemical assay with samples taken after treatment in accordance with the inspection after treatment requirements shown below and the AWP Standards listed in Table H.

TABLE G

MINIMUM REQUIREMENTS FOR RETENTION OF PRESERVATIVE			
PRESERVATIVE	RETENTION kg/m ³ (lb/cu ft)		AWPA STANDARD
	POSTS	BLOCKS	
CCA, ACA, OR ACZA	9.61 (0.60)	6.41 (0.40)	A11

If blocks are treated along with posts, retention of the charge shall be determined by assay of borings from posts.

m. Penetration. The penetration requirements for heartwood and sapwood shall be as specified in Table I. Samples to determine penetration shall be taken after treatment in accordance with the inspection after treatment requirements shown below.

TABLE H

PENETRATION REQUIREMENTS FOR POSTS AND BLOCKS		
SPECIES	MINIMUM PENETRATION	
	HEARTWOOD	SAPWOOD
Permitted Species*	8 mm (0.3 in.)	15 mm (0.6 in.) or 90 percent, whichever is greater

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* For Red Oak, 65 percent of the total annual rings shall be penetrated. If this is not possible, properly conditioned wood may be treated to refusal.

n. Inspection After Treatment. Following treatment, the charge shall be examined by the treater for cleanliness; mechanical damage to individual pieces; treatment damage such as severe checking, splitting, or honeycombing; and for untreated areas resulting from air pockets, floating material, or insufficient height of preservative. All such material shall be removed from the remaining acceptable material before shipment.

400

Sampling and testing for preservative retention and penetration will be done by the Department.

o. Branding. All posts and blocks shall be burn branded clearly and permanently on one of the wide faces. The brand shall be within 300 mm (12 in.) of the top of the post. The brand shall show the treater's identification, the plant designation, and the year of treatment. The month may also be included. The brand shall also show the species or group code designation shown in Table J, the preservative type, and retention, all in accordance with AWPA Standard M6.

410

p. Conformance. The treating plant supplying the material shall be responsible for and will be required to supply a certificate indicating the species, grade, preservative type, retention, year, and name of treater.

TABLE I

GROUP CODING AS AN ALTERNATE TO SPECIES CODING*	
GROUP	CODE
Hardwoods	MH
Jack Pine	J
Other Softwoods	MS

* Species designated in Tables A and B

q. Records. Copies of treating records, analysis records, and other records which may be necessary to determine accordance with specifications shall be made available to Department personnel or their designated representatives upon their request. Required information shall be that which is listed in Part 7.2 of AWP Standard M2. These records shall be retained by the treating plant for five years from the date of material shipment.

r. Independent Inspections. The Department may inspect the material or call for a non-Departmental inspection to verify that it is in accordance with all specifications.

6. Field Treatment of Posts and Blocks. Cuts, holes, or injuries to the surface of posts and blocks which occur after pressure treatment shall be field-treated by brushing, spraying, dipping, soaking, or coating. The Contractor shall ensure that all injuries, such as abrasions and nail and spike holes, are thoroughly saturated with the field-treating solution. Holes bored in pressure-treated materials shall be poured full of preservative. Horizontal holes may be filled by pouring the preservative into the holes with a bent funnel after temporarily plugging the other end of the hole.

The solution used for field treatment shall be a 20 percent solution of copper naphthenate.

7. Rejection for Degradation After Treatment. Guardrail posts or blocks developing the following degradation prior to installation will be rejected regardless of prior approvals.

- a. Single checks greater than 75 mm (3 in.) deep or checks opposite each other totaling more than 75 mm (3 in.) deep, measured with a probe not more than 2 mm (1/16 in.) thick.
- b. Single checks 6 mm (1/4 in.) wide or wider measured at the widest point, and extending more than one third of the length of the post or block.
- c. Single checks greater than 10 mm (3/8 in.) wide measured at the widest point.
- d. Splits greater than 75 mm (3 in.) long which are in the plane of the bolt hole.

e. Crooks or bows exceeding 25 mm (1 in.) per 3.0 m (10 ft) length, and all twists.

460

f. Combinations of checks, splits, or shakes which are otherwise in accordance with the specifications but which may cause the post or block to separate into several pieces.

(g) Preservatives. Preservatives shall be in accordance with AASHTO M 133 as modified by EPA regulation.

1. Waterborne Preservatives. Waterborne preservatives shall be in accordance with AWWA-P5, and shall be Acid Copper Chromate, Ammoniacal Copper Arsenate, or Chromated Copper Arsenate.

SECTION 912 -- CONCRETE CURING MATERIALS AND ADMIXTURES

912.01 Curing Materials. Curing materials shall be in accordance with the following requirements.

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(a) Burlap Cloth made from Jute or Kenaf. This material shall be new, or reclaimed and thoroughly vacuum cleaned burlap. Burlap from sugar, salt, or fertilizer bags shall not be used. The burlap shall weigh no less than 3.4 kg/m² (10 oz/sq yd) and shall be in strips of not less than 1.0 m (40 in.) nor more than 3.0 m (120 in.) wide and no less than 0.60 m (2 ft) longer than the width of the pavement being cured.

(b) Waterproof Paper Blankets. These blankets shall be in accordance with AASHTO M 171.

(c) White Polyethylene Sheeting, Film. The sheeting shall be in accordance with AASHTO M 171.

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(d) White Burlap Polyethylene Sheet. These sheets shall be in accordance with AASHTO M 171.

(e) Liquid Membrane Forming Compounds. These compounds shall be in accordance with AASHTO M 148, type 2, except the drying time requirement will be determined on a glass surface.

912.02 Curing-Sealing Materials. Curing-sealing materials are single application curing and sealing products for portland cement concrete.

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A List of Approved Curing-Sealing Materials will be maintained by the Department. The list will identify preapproved products, specify the manufacturer and product designation, and include application instructions.

In order to have a product added to the List of Approved Curing-Sealing Materials, the manufacturer shall furnish to the Materials and Tests Division a type A certification in accordance with 916. Such certification shall state that the product is in accordance with the

requirements of NCHRP 244 Series IV Southern Climate Weathering Test, and AASHTO M 148 Type 1.

- 40
- (a) The certification shall be in accordance with the applicable requirements of 916, and shall include a dated test report. The test report shall substantiate full compliance with the specifications and establish when the testing was started. Test reports older than seven years on January 1 of the approval year will not be accepted.
 - (b) If irregularities are found in the results required for such certification, copies of the original data may be required prior to reconsideration of the certification.
 - (c) Tests must be conducted by a state highway agency testing laboratory or a testing laboratory regularly inspected by CCRL. Proof of such inspection shall be furnished with the test report.
- 50

After a product has been approved, it will be added to the List of Approved and/or Prequalified Materials. The product will remain on the List until test results on file are seven years old, provided that there are no changes in raw materials, formulation, or procedures for manufacture. Results more than seven years old or products in which there has been a change in raw materials, formulation, or procedures for manufacture shall be recertified in order to remain on the List.

60 A curing-sealing material that performs unsatisfactorily in the field will be removed from the approved list.

912.03 Admixtures for Use in Concrete. Admixtures containing chloride added as an ingredient of manufacture are unacceptable.

(a) Air Entraining Admixtures. Air entraining admixtures are materials to be added to portland cement concrete mixtures at the mixer for the purpose of entraining air. These admixtures shall be in accordance with AASHTO M 154.

70 **(b) Chemical Admixtures for Concrete.** Chemical admixtures are materials to be added to portland cement concrete mixtures at the mixer for the purpose or purposes indicated below. The admixtures shall be in accordance with AASHTO M 194 for their respective types.

1. Type A. Type A is a water reducing admixture that reduces the quantity of mixing water required to produce concrete of a given consistency.

2. Type B. Type B is a retarding admixture that retards the setting of concrete.

80 **3. Type C.** Type C is an accelerating admixture that accelerates the setting and early strength development of concrete.

4. Type D. Type D is a water reducing and retarding admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and retards the setting of concrete.

5. Type E. Type E is a water reducing and accelerating admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and accelerates the setting and early strength development of concrete.

6. Type F. Type F is a high range water reducing admixture, HRWR, that reduces the quantity of mixing water required to produce concrete of a given consistency by 12 percent or greater.

7. Type G. Type G is a high range water reducing and retarding admixture, HRWRR, that reduces the quantity of mixing water required to produce concrete of a given consistency by 12 percent or greater and retards the setting of concrete.

8. High Range Water Reducing and High Range Water Reducing and Retarding Admixture Systems. HRWR and HRWRR admixture systems typically utilize an air entraining agent; a type A or type D chemical admixture; and a type F chemical admixture, for HRWR, or a type G chemical admixture, for HRWRR.

(c) Certification. Prior to furnishing admixtures, each manufacturer shall furnish to Division of Materials and Tests a certification in accordance with the following:

1. For air entraining admixtures manufactured by neutralizing Vinsol resin with sodium hydroxide in accordance with AASHTO T 157, the certification shall certify that:
 - a. The product is (brand name)
 - b. Is manufactured by (manufacturer's name)
 - c. Is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide
 - d. The ratio of sodium hydroxide to Vinsol resin is one part of sodium hydroxide to (number) parts of Vinsol resin by mass (weight)
 - e. The percentage of solids based on residue at 105EC (221EF) is (number)
 - f. No other additive or chemical agent is present in this solution.

If the air entraining admixture is manufactured in proportions other than set out in AASHTO T 157 for the referenced admixture, the certification shall include a dated test report substantiating compliance with the specifications.

2. For type A, B, C, D, and E admixtures, the certification shall:

- 140
- a. State the chloride content
 - b. State whether or not chloride is added as an ingredient of manufacture
 - c. State that the admixture complies with these specifications
 - d. Include a dated test report substantiating full compliance with the specifications. If irregularities are found in the test results required for the aforementioned certification, copies of the original data may be required to be submitted prior to reconsideration of the certification.
- 150
3. For HRWR and HRWRR admixture systems that contain an air entraining agent; a type A or type D chemical admixture; and a type F or type G chemical admixture, the certification shall:
 - a. State the product names.
 - b. State the manufacturer's name(s).
 - c. State the character of the materials.
 - d. State the chloride contents.
 - e. State whether or not chloride is added as an ingredient of manufacture.
- 160
- f. State that the type A or type D chemical admixture and the air entraining agent is in accordance with 912.03(c) for their respective types.
 - g. Include a dated test report substantiating full compliance of the type F or type G chemical admixture with 912.03(c) and AASHTO M 194.
 - h. Include a dated test report substantiating full compliance of the HRWR or HRWRR admixture system with AASHTO M 194 for type F or type G chemical admixture, except as follows:
- 170
- (1) The HRWR or HRWRR admixture system shall be used in the test concrete.
 - (2) The control concrete shall contain the same air entraining agent used in the HRWR or HRWRR admixture system.
 - (3) The six month and one year compressive strength testing will be waived and flexural strength testing will not be required.
 - (4) Uniformity and equivalence testing will not be required.
- 180
- (5) Testing for length change shall not be required.

- (6) A sample of the test concrete containing the HRWR or HRWRR admixture system shall be tested for hardened concrete air void system analysis in accordance with ASTM C 457. The sample for hardened concrete air void system analysis shall indicate an air content of at least 4.5% for class C, and 5.2% for class A; a voids per millimeter (inch) parameter of at least 0.0492 (1.25) times the air content; a spacing factor of 0.254 mm (0.010 in.) or less; and a specific surface of $19.685 \text{ mm}^2/\text{mm}^3$ ($500 \text{ in.}^2/\text{in.}^3$).

4. For HRWR and HRWRR admixture systems that contain only an air entraining agent and a type F or type G chemical admixture, the certification shall:

- a. State the product names.
- b. State the manufacturer's name(s).
- c. State the character of the materials.
- d. State the chloride contents.
- e. State whether or not chloride is added as an ingredient of manufacture.
- f. State that the air entraining agent is in accordance with 912.03(c).
- g. Include a dated test report substantiating full compliance of the type F or type G chemical admixture with 912.03(c) and AASHTO M 194 except as follows:

- (1) The HRWR or HRWRR admixture system shall be used in the test concrete.
- (2) The control concrete shall contain the same air entraining agent used in the HRWR or HRWRR admixture system.
- (3) A sample of the test concrete containing the HRWR or HRWRR admixture system shall be tested for hardened concrete air void system analysis in accordance with ASTM C 457. The sample for hardened concrete air void system analysis shall indicate an air content of at least 4.5% for class C, and 5.2% for class A; a voids per millimeter (inch) parameter of at least 0.0492 (1.25) times the air content; a spacing factor of 0.254 mm (0.010 in.) or less; and a specific surface of $19.685 \text{ mm}^2/\text{mm}^3$ ($500 \text{ in.}^2/\text{in.}^3$).

5. The tests shall be performed by a recognized laboratory which is a state highway agency testing laboratory, or a cement or concrete laboratory regularly inspected by the CCRL. Proof of such inspection shall be

230 furnished on request. The test report shall be dated to establish when the
testing was started. Test reports more than five years old on January 1 of
the approval year will be unacceptable.

240 After the certification specified in the preceding paragraph has been approved and
provided that the required test results are still not more than five years old as specified
above, each manufacturer shall submit an annual certification of compliance with those
specifications as previously described except, if there has been no change in raw materials,
formulation, or procedures, test results will not be required. The certification shall indicate
that the material is of the same formulation as that for which test results have been
submitted. When the initially submitted complete test results are more than five years old as
specified above, a complete certification with new limited retest results shall be required.
These limited retest results shall comply with the dating and age requirements specified
above and shall include the following AASHTO M 194 test as a minimum requirement for
compliance:

- a. infrared analysis, residue by oven drying, and specific gravity;
- b. water content and time of setting as referenced in AASHTO MC 194;
- 250 c. flexural strength at three, seven, and 28 days;
- d. relative durability.

(d) Approved Admixtures. The Department will maintain a list of Approved
Admixtures and Approved Admixture Systems.

(e) Performance of Admixtures. The use of concrete admixtures which results
in unsatisfactory performance will be prohibited.

260 **912.04 Latex Modifiers.** The latex modifiers are an admixture to be added to the
concrete mixture at the continuous mixer. The latex shall be one of the latex modifiers in the
list of approved Admixtures for Portland Cement Concrete.

The formulated latex admixture shall be a non-toxic, film forming, polymeric
emulsion in water to which all stabilizers have been added at the point of manufacture and
shall be homogeneous and uniform in composition. A type B certification shall be furnished
in accordance with 916.

270 **912.05 Mineral Admixtures.** Microsilica shall be in accordance with AASHTO
M 307. A type B certification shall be furnished in accordance with 916.

Physical properties of the latex modifier shall be in accordance with the following:

Polymer Type	Styrene Butadiene
Stabilizers	Anionic and Nonionic Surfactants
Antifoaming Agent	Polydimethyl Siloxane
Percent Solids, % by mass	46.0 Minimum
Mass Per Liter (Gallon).....	1.0 kg (8.4 lb) at Minimum

	pH (as shipped).....	9.0-11.0
280	FreezeXThaw Stability.....	Five Cycles, -15E to 25EC
	Shelf Life.....	Two Years, Minimum
	Color.....	White

SECTION 910 -- METAL MATERIALS

910.01 Reinforcing Bars and Dowel Bars

(a) General

(b) Specific Requirements

1. Billet Steel Bars

2. Threaded Tie Bar Assembly

3. Splicing Systems

4. Blank

5. Welded Steel Wire Fabric for Concrete Reinforcement

6. Welded Deformed Steel Wire Fabric for Concrete Reinforcement

7. Uncoated 7 Wire Strand for Prestressed Concrete

8. Steel Spiral Reinforcement

9. Epoxy Coated Reinforcing Bars

10. Dowel Bars

(c) Inspection, Sampling, and Testing

910.02 Structural Steel

(a) Structural Steel

(b) High Strength Structural Steel

(c) Charpy V-Notch Toughness Tests

(d) Mill Test Reports

(e) High Strength Bolts, Nuts, and Washers

1. General Use

2. Assembly of Structural Steel in Bridges

a. Bolts

b. Nuts

c. Tests

(1) Rotational Capacity

(2) Proof Loads

(3) Wedge Tension Test

d. Certification

(f) Bolts other than High Strength Bolts

1. General

2. Unfinished Bolts

3. Turned Bolts

4. Ribbed Bolts

910.03 Permanent Metal Forms

910.04 Steel Forgings and Steel Shafting

(a) Carbon Steel Forgings

(b) Cold Finished Carbon Steel Shafting

(c) Alloy Steel Forgings

(d) Certification

910.05 Castings

(a) Steel Castings

1. Steel Castings for Highway Bridges

2. Chromium Alloy Steel Castings

(b) Iron Castings

(c) Ductile Iron Castings

(d) Malleable Castings

(e) Carbon Steel Castings

910.06 Bronze and Copper Alloy

(a) Bronze Castings

(b) Copper Alloy Plates

910.07 Steel Drain Pipe

	910.08 Miscellaneous
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	(b) Sheet Zinc
	910.09 Guardrail
	(a) Steel Beam Rail
	(b) Aluminum Rail
60	910.10 Guardrail Posts
	(a) Steel Guardrail Posts
	Aluminum Guardrail Posts
	(c) Wood Guardrail Posts
	910.11 Guardrail Accessories, Fittings, and Hardware
	(a) For Steel Beam Guardrail
	(b) For Aluminum Guardrail
	(c) For Steel Tube Guardrail
	910.12 Samples and Certification of Guardrail, Posts, Accessories, Fittings, and Hardware
70	(a) Control Procedure for Furnishing Steel Beam Guardrail and Accessories
	(b) Aluminum Guardrail
	910.13 Steel Fence Posts
	(a) Tubular Steel Fence Posts
	1. Group 1
	2. Group 2
	(b) Fence Fastenings
	910.14 Sign Posts
	(a) Steel, Flanged, Channel Posts
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80	2. Deflection Test Requirements
	3. Type of Posts
	(b) Wide Flange Posts
	(c) Structural Steel Posts
	(d) Structural Aluminum Posts
	(e) Square Steel Posts
	1. Steel
	2. Fabrication
	3. Protective coating
	910.15 Delineator Posts
	910.16 Copper Flashing
90	910.17 Bronze or Copper Alloy Plates
	910.18 Fence, Fittings, and Gates
	(a) Farm Field or Woven Wire Fence
	(b) Steel Fabric Chain Link Fence
	1. Tension Wire
	2. Stretcher Bars, Truss Rods, and Turnbuckles
	3. Braces
	4. Barbed Wire
	(c) Aluminum Fabric Chain Link Fence
100	(d) Gates
	1. Steel Gates
	2. Aluminum Gates
	(e) Control Procedures for Furnishing Fence and Accessories
	1. General Requirements
	2. Suppliers of Pretested Approved Stockpiled Material
	3. Suppliers Not Furnishing Pretested Approved Stockpiling Material
	910.19 Overhead Sign Structures
	(a) Aluminum Overhead Sign Structures, Box Truss and Bridge Attached
	(b) Steel Overhead Sign Structures, Box Truss, Cantilever, Monotube, and Bridge Attached
	910.20 Blank
110	910.21 Steel Sheet Piling
	SECTION 911 -- WOOD MATERIALS
	911.01 Untreated Lumber

	(a) General
	1. Boards
	2. Dimension Lumber
	3. Structural Lumber
	4. Timbers
	5. Timbers, Round
120	6. Yard Lumber
	7. Surfaced or Dressed Lumber
	8. Rough Lumber
	(b) Species and Grade
	(c) Inspection
	(d) Tolerances
	(e) Untreated Piling
	911.02 Treated Lumber
	(a) General
	(b) Bridge Lumber
130	(c) Piling
	(d) Guardrail Posts, Braces, and Battens
	(e) Sign Posts
	(f) Sawed Timber Posts and Blocks for Thrie-Beam and W-Beam Guardrail
	1. Species and Grades
	2. Department Grade GRP
	a. Splits
	b. Checks
	c. Shakes
	d. Stains
140	e. Slope of Grain
	f. Wane
	g. Knots
	3. Department Grade GRB
	a. Splits
	b. Checks
	c. Shakes
	d. Stains
	e. Wane
	f. Knots
150	4. General Requirements
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	b. Unsound Wood
	c. Crook or Bow
	d. Dimensional Tolerances
	5. Pressure Treating Posts and Blocks
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	c. Inspection Before Treatment
	d. Test for Moisture Content
160	e. Preservative Treatment
	f. Material for Preservative Treatments
	g. Treatment Methods
	h. Sorting and Spacing
	i. Conditioning
	j. Treatment
	k. Inspection During Treatment
	l. Retentions
	m. Penetration
	n. Inspection After Treatment
170	o. Branding
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	q. Records

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912.01 Curing Materials

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912.03 Admixtures for Use in Concrete

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- ## 912.04 Latex Modifiers

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